

february 1958

nlgi spokesman

journal of the national lubricating grease institute

NLGI Grease Production Survey

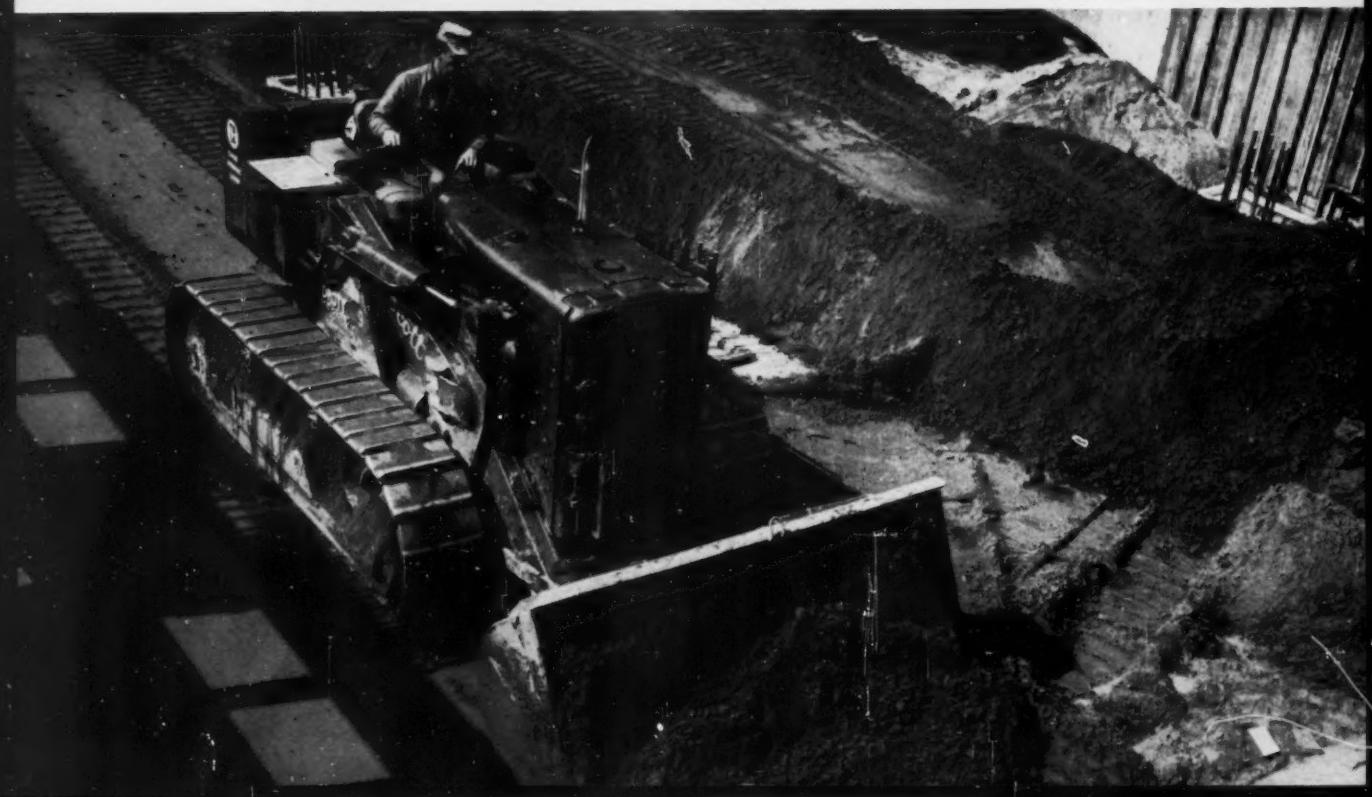
General Motors Looks at Rear Axle Lubricants—September 1957

By N. A. HUNSTAD

Lubricating the Construction Giants

By G. K. BROWER

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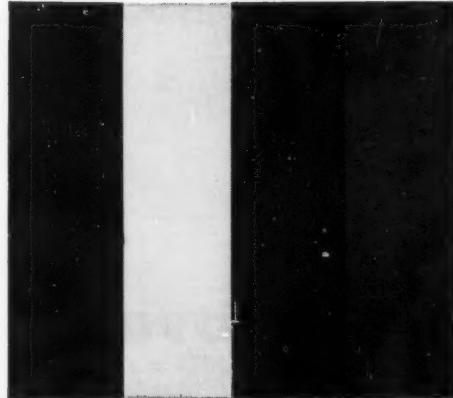
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NLGI PRESIDENT'S PAGE

By R. CUBICCIOTTI, President



How Good is Our Publicity?

A previous message pointed up the progress the lubricating grease industry was making to keep pace with the increasing demands of our "space-satellite age."

Yet, how much of our activity is the public aware of?

Certainly we owe it to the nation as a whole, as well as to ourselves to disseminate as much as we possibly can of the story of the lubricating grease industry and the role it plays in our country's progress. This is not to say that we have been keeping entirely quiet. The point is:

Have we been telling our story to the public or have we just been talking among ourselves? Just how good is our public relations?

Perhaps we should take time to draw up a sort of public relations checklist. Frank answers to frank questions should help to clarify in our minds what has to be done and how it should be done. Let us ask ourselves:

Are we telling our story?

Are we telling it properly, or are we being too technical? Does our message get across?

How much does the public understand about lubricating grease? For what part of this understanding, if any, can we claim credit?

Are we creating the right climate for a bigger grease market in the future? Are we making the public aware

of the need and the importance of lubricating grease? And last, but of utmost importance—

Are we succeeding in attracting the best engineers to our industry? Are we laying the proper groundwork for a continuation of the kind of progress of which we are so proud?

These and other questions can be answered satisfactorily only if we set our sights on some realistic goals. What is needed is a program that we can all practice. And while this need not be a rigid, spelled-out undertaking, such a program should:

Dramatize the story of grease through better and more frequent dissemination of the facts in a form the public can understand and evaluate properly.

Encourage the participation of every member of the NLGI. This participation should encompass every conceivable front—talks before industry groups which could be reported in the popular press; preparation of educational material; publication of research findings; stimulation of interest in our industry among students, etc.

We'd like to be able to do the entire job at the NLGI. This is, of course, a practical impossibility. But if every member company does its part, our goal will be many steps closer to realization. For only then will we be able to say we have met the problem and we—all of us together—have licked it. ■

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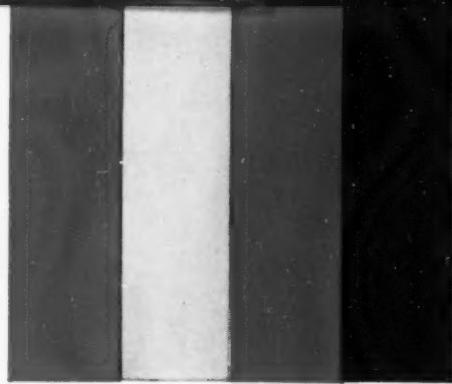
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News About NLGI

Ernst & Ernst Deliver Survey Forms

Actual delivery of the approved questionnaire forms for the first NLGI lubricating grease production survey (see page 11) was made by registered mail to all Active members in the United States. Mailed to manufacturers by registered mail, the forms ask for production in pounds for the calendar year of 1957.

The certified public accounting firm of Ernst & Ernst is compiling the survey for NLGI. Unmarked envelopes from E & E to the manufacturer contain the questionnaires. . . . Actives return the questionnaires in other E & E envelopes. Mail is registered, both ways.

Complimentary Spokesman Copies Reviewed

Members of the National Lubricating Grease Institute are asked to check and note if they are taking full advantage of complimentary membership subscriptions allowed on the Institute's technical journal—the NLGI SPOKESMAN.

Each member firm is allowed a certain number of membership copies based on the dues structure paid to the Institute. With the exception of Technical member firms this is figured roughly at one free membership copy per twenty dollars dues paid for the calendar year.

A great many firms have used up their allotment while others do not employ the total number of magazines allowed. Those companies wanting to enact new complimen-

tary member subscriptions may do so by merely writing the NLGI national office in Kansas City. If a review of subscriptions is necessary, the staff will be glad to submit a list of those readers now receiving the magazine.

Additional magazines over and above the membership allotment may be purchased by members at one-half the rate for non-members. Thus, a domestic member paid subscription would be \$2.50 rather than \$5.00 for twelve issues. Overseas subscriptions for members are \$4.00 while for non-members the rate is \$6.00.

Volume 21 Available With Next Issue

With the printing of this February, 1958 issue of the NLGI SPOKESMAN the completion of another volume of the magazine is almost at hand. Next month's March journal will be Number 12 of Volume XXI, with binding of copies to immediately follow.

Bound volume orders for XXI will be accepted and filled upon receipt of the book . . . those firms desiring copies may place orders beforehand to get immediate service.

A few copies of Volume XVIII are still in stock, along with a larger quantity of Volume XIX. Volume XX is in good supply. For those firms wanting a complete book going back to Volume XIII and desire the compactness of microfilms, copies are available through University Microfilm, Ann Arbor, Michigan,

at a nominal charge.

All NLGI SPOKESMAN bound volumes come in a handsome and sturdy green binding, complete with gold lettering on the covers and backs. A matched set of books is a valuable addition to the reference library.

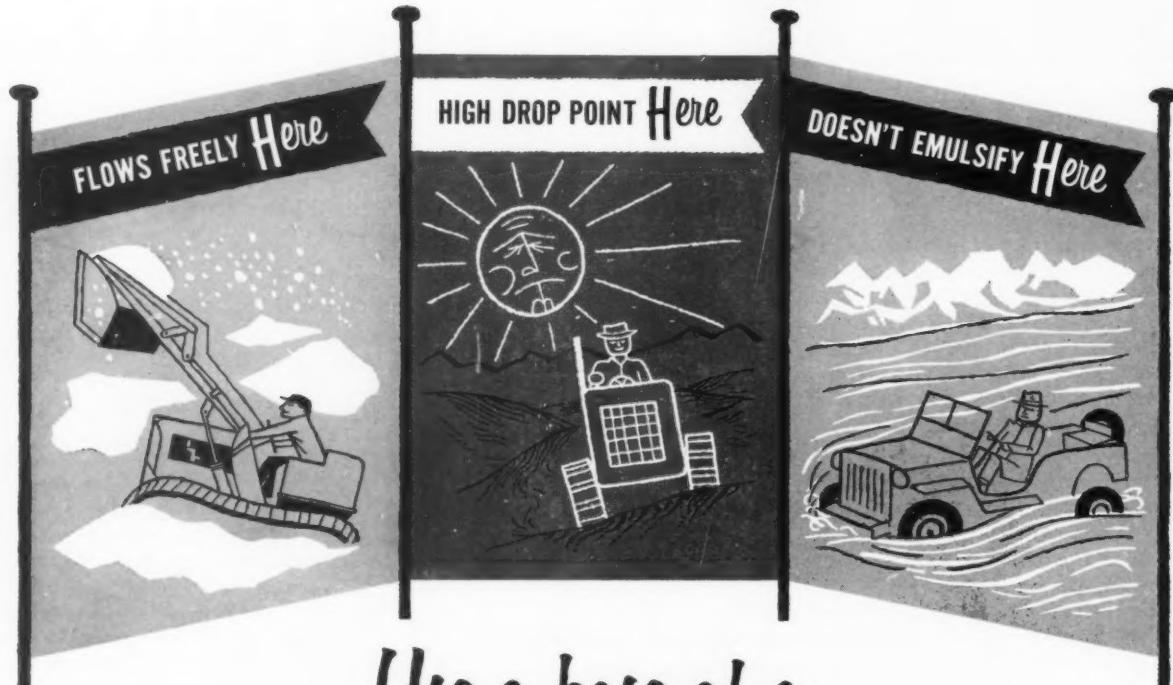
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● **NLGI MOVIE — "Grease, the Magic Film," a 16-mm sound movie in color running about 25 minutes, now released. First print \$600, second print \$400, third and subsequent orders \$200 each (non members add \$100 to each price bracket).**

● **VOLUME XX — Bound volume of the NLGI SPOKESMAN from April, 1956 through March, 1957. An excellent reference source, sturdily bound in a handsome green cover . . . \$7.00 (NLGI member price) and \$10.00 (non-member) plus postage.**

● **BONER'S BOOK—Manufacture and Application of Lubricating Greases, by C. J. Boner. This giant, 982-page book with 23 chapters dealing with every phase of lubricating greases is a must for everyone who uses, manufactures or sells grease lubricants. A great deal of practical value. \$18.50, prepaid.**

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THE COVER

AN INTERNATIONAL Harvester Construction giant at work clears a trench for final grade, and although weather conditions in this photo appear ideal, author G. K. Brower (see article beginning on page 21) points out that contractors equipment will be used in a variety of terrain, climates and weather conditions. Therefore, lubricating recommendations should be such that they can be followed wherever the location of the work may be. This is the second of a series of articles on the lubrication of contractors' equipment which were presented at the NLGI Annual Meeting last October.

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FORMS FOR 1957 PRODUCTION OF LUBRICATING GREASES AND

SURVEY

FLUID GEAR LUBRICANTS RELEASED IN FIRST NLGI SURVEY

THIS WAS NOT LARGE as mailings go but in importance NLGI'ers think that the envelopes registered with the post office on Wednesday, January 15, 1958, make that date particularly significant for the National Lubricating Grease Institute.

The mid-January mailing of 62 envelopes bearing an Ernst & Ernst letterhead was the dispatching of certified questionnaires on the NLGI 1957 lubricating grease production survey . . . the first in what can be an exceptional series of valuable delineations. By the closing date some two and a half months later it is estimated that the great majority of U. S. manufacturing member firms of the Institute will have participated in this industry innovation and that an accurate resume of production can then be offered the *entire* membership.

To insure the confidential aspect of the survey, all communication pertaining to the figures originates *only* between the certified public accounting firm handling the statistics and the participating manufacturers of lubricating grease . . . hence the exchange of mail in unmarked Ernst & Ernst envelopes. Mail is registered both to and from the Active members. After the final tally by Ernst & Ernst the anonymous replies will be destroyed and only then will a final result be turned over to the national office.

Preparation has been long and careful, involving a great many Company and Technical representatives from within NLGI for the planning. Even the correlating agency selected was a matter of considerable study—the nation wide firm of Ernst & Ernst was chosen because of their work in surveys for other associations and societies.

As first envisioned the survey dealt with lubricating grease only. After NLGI declared its interest in gear

lubricants, the survey was enlarged to include this product in pounds produced, but without reference to ingredients. Given below is the list of definitions and instructions for the survey asked of Active members:

1. Include all domestic *production* rather than sales data. In reporting your figures, be guided by the following ASTM definition for lubricating grease:
Lubricating grease—a solid to semi-fluid product of dispersion of a thickening agent in a liquid lubricant. Other ingredients imparting special properties may be included.
2. Include all production regardless of destination; i.e., whether domestic or export.
3. Greases containing two or more thickeners should be listed under the category whose characteristics predominate.
4. Make no separate listing of EP greases.
5. Do not include process oils, cutting oils, textile oils, etc., in the above figures.
6. Report total production in pounds of fluid gear lubricants, even though your product is sold by the gallon. Do *not* include production of fluid gear lubricants in the grand total production of lubricating greases as defined.

The real value in this service lies of course, in the future . . . from a modest beginning the survey can in time be a merchandising and research tool embodying various aspects not even thought of in this formative period. Through the cooperation of those participating firms the 1957 NLGI survey of lubricating grease production can be a Silver Anniversary milestone to be proud of. ■

General Motors Looks at Rear Axle Lubricants—Sept. 1957



This paper was preceded last month by a paper covering the history and development of rear axle lubricants titled, "The Development and Application of a Broad Performance Range Gear Lubricant," by R. K. Williams, W. C. Brandow and J. W. Schulte, the Lubrizol Corp.

By N. A. Hunstad
General Motors Corporation

Presented at the National Petroleum Association 55th Annual Meeting September, 1957 in Atlantic City, N.J.

SOME PEOPLE THINK that the present gear lubricant picture is confusing. Moreover, to some it has appeared confusing in the past as well as at the present time. In fact, in a paper¹ presented in 1939, Professor A. O. Willey of the Case School of Applied Science made the following comment: "Although test methods have been developed, results accumulated, and specifications drawn up, covering numerous phases of hypoid lubrication, it is still the opinion of many engineers that the situation today is as complicated and confusing as at any time during its development. The intensity and scope of recent experimental work together with the resulting multiplicity of tests and specifications have probably been instrumental in further confusing the problem rather than aiding in its simplification."

We at General Motors agree that the rear axle lubricant problem is complicated both from an industry standpoint and within GM alone. However, while the industry picture may appear to be confused, we believe that a study of General Motors rear axle lubrication recommendations will show a logical progression based on results of car tests as well as service experience. I would like to review some of the history of, and reasons for, our rear axle lubrication recommendations.

It is of interest in this regard to reach back a considerable distance in history and examine some of our earliest axle lubrication recommendations. As an example, the 1909 Cadillac Instruction Book had this to say with regard to rear axle lubrication: "The best lubricant for this part (the rear axle) is a mixture of cup grease and oil, mixed to such a consistency that it will not be so thick that the gears will simply cut a path in it, but be just liquid enough to flow." I think you will agree that even this early recommendation was perfectly straight forward and that there was nothing confusing about it.

Admittedly, the type of axle in today's cars and the service expected from current units are quite different from those of the 1909 Cadillac. The combination of hypoid gears and the performance capabilities of our present vehicles make the rear axle lubricant requirements considerably more stringent.

General Motors Past Hypoid Lubricant Recommendations

When General Motors adopted the hypoid axle in 1937, they fully recognized the special lubricant requirements of this type of unit by virtue of the experience of other manufacturers using the hypoid axle, as well as of their own experience in testing this type of gear. Accordingly, the owners manuals for the 1937 models recommended either a "Hypoid EP lubricant"

LEFT, "A unit which is the subject of intensive interest at the moment", states author, is the 1957 Chevrolet positraction rear axle. The parts shown: A. differential case, B. cross pins, C. cam surfaces, D. disc clutches, E. axle shafts.

or, in the case of one division, a "Special hypoid lubricant" which was obtained directly from the car dealer. The three divisions using the hypoid gear in 1937 were in agreement with regard to drain interval and they all specified that the axle be drained "twice yearly, or every 6,000 miles."

These recommendations are shown in Figure 1, together with those for subsequent years through 1957. As shown here, the recommendations for lubricant type have varied through the subsequent years from "Hypoid lubricant" in 1938 and 1939 to "Passenger car duty hypoid lubricant" or "All purpose" or "Universal gear lubricant" from 1940 through 1948. The recommendation has been the same, "Passenger car duty hypoid lubricant" or "Multi-purpose gear lubricant", from 1949 through 1957.

The drain interval recommendations have not been

Figure 1
General Motors Hypoid Rear Axle Lubricant Recommendations

Model Year	Lubricant Type	Drain Interval
1937	Hypoid EP Lubricant or Special Hypoid Lubricant	Twice yearly, or every 6,000 miles
1938-39	Hypoid Lubricant	Twice yearly, or every 6,000 to 10,000 miles
1940-41	Passenger Car Duty Hypoid Lubricant, All Purpose or Universal Gear Lubricant	Twice yearly, or every 6,000 to 10,000 miles, or once a year or every 15,000 miles
1942	Passenger Car Duty Hypoid Lubricant, All Purpose Gear Lubricant	Twice yearly, or every 6,000 to 10,000 miles, or do not drain (1)
1946	Passenger Car Duty Hypoid Lubricant, All Purpose Gear Lubricant	Twice yearly, or every 6,000 to 10,000 miles, or do not drain (2)
1947	Passenger Car Duty Hypoid Lubricant, All Purpose Gear Lubricant	Twice yearly, or every 6,000 to 10,000 miles, or do not drain (3)
1948	Passenger Car Duty Hypoid Lubricant, All Purpose Gear Lubricant	Twice yearly, or every 6,000 to 10,000 miles, or do not drain (4)
1949	Passenger Car Duty Hypoid Lubricant, Multi-Purpose Gear Lubricant	Twice yearly, or every 6,000 to 10,000 miles, or do not drain (5)
1950	Passenger Car Duty Hypoid Lubricant, Multi-Purpose Gear Lubricant	Twice yearly, or every 6,000 to 10,000 miles, or do not drain (6)
1951-56	Passenger Car Duty Hypoid Lubricant, Multi-Purpose Gear Lubricant	Do not drain (5)
1957	Passenger Car Duty Hypoid Lubricant, Multi-Purpose Gear Lubricant	10,000 miles, or do not drain (4)

Compiled with the assistance of the Chek-Chart Corp.

as consistent as the lubricant type recommendations among the General Motors divisions. In 1938 some divisions increased the interval to 10,000 miles, in 1940 one division specified a drain "once a year or every 15,000 miles," in 1946 one division recommended no drain, in 1947 there were two divisions that did not recommend a drain, in 1948 there were three, in 1950 there were four, and finally, in 1951 all five car divisions were in agreement in not recommending any rear axle drain. In 1957 one division re-established the drain recommendation, specifying a 10,000-mile interval.

To Drain or Not to Drain

What is the explanation behind these drain interval recommendations? The arguments as to whether a drain interval is desirable will probably continue as long as axle gears are manufactured. There are many reasons, for instance, that may be advanced in favor of no axle lubricant drain. Some people say that due to careless service station procedures, dirt is introduced into the axle during draining and refilling, dirt which later leads to excessive gear and bearing wear and the resultant shortening of axle life. Another reason advanced by opponents of drain periods is the axle failure caused by leaving an excessive amount of flushing oil in the axle in a draining and refilling process. Also, one General Motors division ran a test on one occasion where they concluded that the draining and refilling process is not effective in removing any of the dirt in the axle. Then, too, according to field and test experience, many of the multipurpose lubricants available are considerably inferior to the factory-fill lubricant installed by General Motors. A very practical consideration is the fact that at least one division has had trouble with drain plugs leaking. The cost of adding a drain plug must be taken into account also, of course. Finally, tests have been run which indicate that no change of lubricant is required and that the original charge is satisfactory for the life of the car.

For instance, when considering the advisability of the no-drain recommendation, one General Motors division ran a 100,000 mile test with lead soap active sulfur factory-fill lubricant without gear failure and found that there was no appreciable change in the sulfur content and no significant change in the lubricant viscosity. More recently, another division ran a similar test for 90,000 miles with lead soap active sulfur lubricant and found no distress in the axle parts at the end of the test.

For various combinations of these, and perhaps other reasons, then, the five General Motors passenger car divisions all recommended no drain in 1951.

On the other side of the question is the argument that dirt is in fact removed in a drain and refill process. Also, some engineers believe that it may be desirable to reduce the "activity" of the lubricant following break-in by going to a multi-purpose lubricant. Fur-

thermore, the proponents of the drain interval maintain that under some conditions lubricants oxidize and that the EP quality may diminish to a dangerous level.

The argument for and against drain is not settled as indicated by the fact that in 1957 one General Motors division recommended a 10,000 mile drain interval, while four continued to recommend no drain. The picture is complicated here by the fact that the one division has also begun the practice of phosphate coating the gears. This coating may provide some additional anti-scoring protection when the axle is drained and refilled with a multi-purpose lubricant of only moderate anti-score quality.

Multi-Purpose Lubricants Inadequate in Anti-Score Quality

In any case, the primary argument during this post-war period when the GM divisions decided not to recommend axle drains seemed to be the inadequate anti-score quality of the service station lubricants. This argument is given some support by tests run by General Motors during the past several years.

In one series of tests cars were run on the 25,000 mile durability schedule at the General Motors Milford proving ground. The cars were broken in on SAE 80 lead soap active sulfur factory-fill lubricant for a period of at least one thousand miles, at which time the lubricant was changed to the multi-purpose test oil.

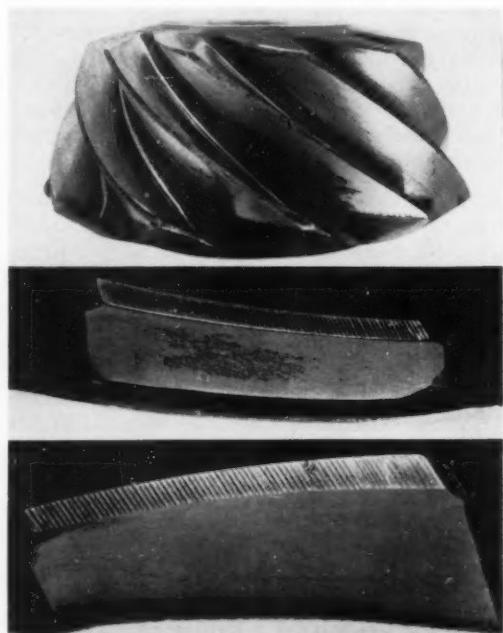


FIGURE 2 illustrates the results with a Chevrolet run on SAE 80 multi-purpose gear oil lubricant for 103 miles.

In some cases the factory-fill lubricant was left in the axle for the entire test. There was particular interest in these tests in the lighter viscosity gear oils and most of the tests were run on SAE 80 gear lubricants.

The next several figures show the results obtained in these tests. In Figure 2 are shown the results with a Chevrolet run on an SAE 80 multi-purpose lubricant for 103 miles. The gross wear and scoring is clearly evident. Note the ridge at the bottom of the pinion teeth indicating the very extensive wear which occurred on the drive side of the teeth.

Figure 3 shows a repeat of this test. In this case the results were similar and the test was stopped with 148 miles on the test lubricant.

The results of a third test on this same lubricant are shown in Figure 4. In this case gears made to the same blueprints but from a different source were used. By examining the drive side of the ring gear teeth, one may see that scoring occurred some time before the test was discontinued at 9,626 miles and the surface of the tooth was partially healed over when the test was discontinued.

These results indicate that there was a quality difference in the gears from these two sources, but that even with the best gear set the SAE 80 multi-purpose lubricant was not adequate in anti-score quality.

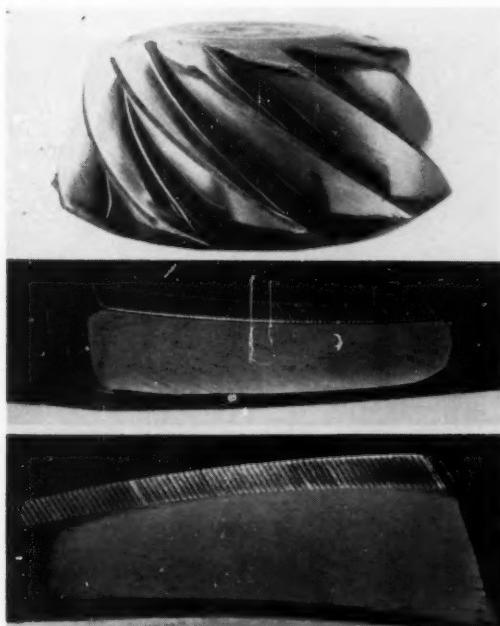


FIGURE 3 shows a repeat of the SAE 80 test allowed to run before being checked with 148 miles on the test lubricant.

Two tests were run on SAE 90 multi-purpose lubricant. The results of the first of these are shown in Figure 5. While the results of these tests are somewhat better than those on the first tests with the SAE 80 lubricant, the gross scoring and wear on the drive side of the tooth is fairly evident. Similar results were obtained in the re-run of this same test as shown in Figure 6. In this case scoring occurred on both the drive and coast sides of the gear.

Finally, tests were run using the lead soap active sulfur SAE 80 factory-fill lubricant. The results are shown in the next two figures. In Figure 7 the high polish on the pinion teeth and the very good condition of the ring gear teeth is clearly shown. This was true in spite of the fact that these gears ran for 25,000 miles as compared to mileages as low as 103 with the multi-purpose lubricant.

The re-run of this test is shown in Figure 8. Here again, the good condition of the gear teeth is evident.

The conclusions reached in this series of tests were that the SAE 80 multi-purpose lubricants can be very poor in anti-score quality, while the SAE 90 lubricants are somewhat better. Even they fall considerably short in anti-score quality when compared to the lead soap active sulfur material.

In order to gain further information on the performance of service station lubricants, tests were run in

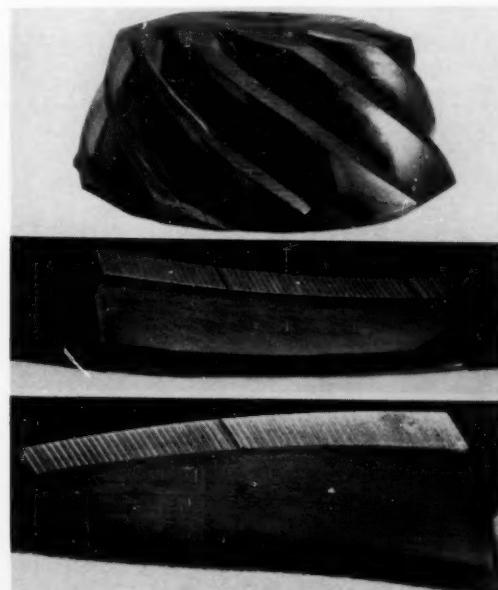


FIGURE 4 shows results of the same SAE 80 lubricant with a Chevrolet driven 9,626 miles. The drive side of ring gear teeth shows scoring began some time before test finish.

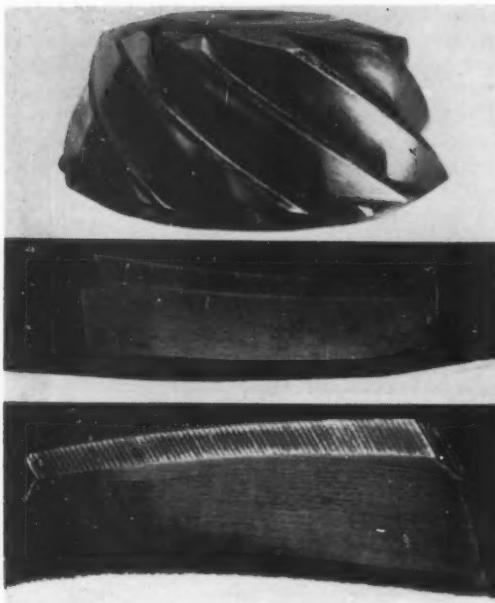


FIGURE 5 shows the results of the first test run on SAE 90 multi-purpose gear oil lubricant on a Chevrolet, with driving distance of 4,035 miles. The results are somewhat better than those on the first tests with SAE 80 lubricant.

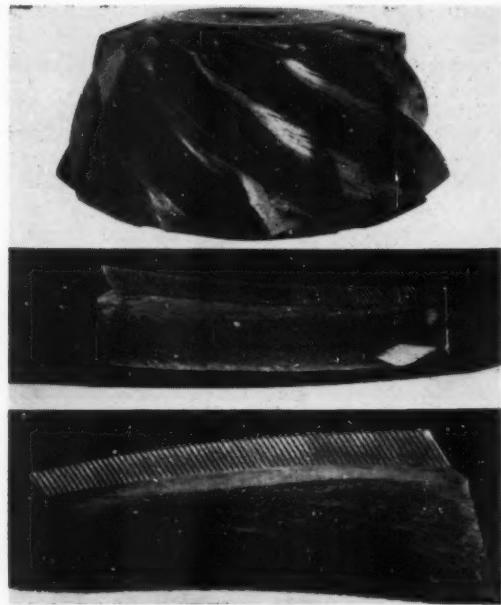


FIGURE 6 is the resulting wear on gear from the same test lubricant, SAE 90 multi-purpose, rated in figure 5, but at 2,804 miles. In this case scoring occurred on both the drive and the coast sides of the gear quite prominently.



FIGURE 7 evidences the good condition of ring gear teeth with tests using lead soap active sulfur SAE 80 oil.

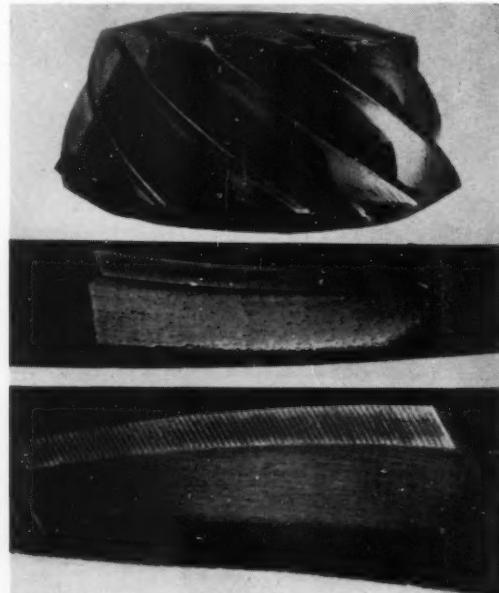


FIGURE 8 is a rerun test result of the lead soap lubricant at 25,251 miles. Condition of the gear teeth is again good.

research staff garage cars in 1954, 1955, and 1956. The axles were broken in on SAE 90 factory-fill lubricant, after which the oil was drained and the test lubricant installed. After a period of operation the axle was again drained and a fresh batch of test lubricant installed.

SAE 80 multi-purpose lubricants were used primarily in the 1954 tests. In one particular car the gears were found to be heavily scored with about 12,000 miles on an SAE 80 multi-purpose lubricant. A new axle and factory-fill lubricant were installed and the multi-purpose again installed after about 1400 miles of break-in on factory-fill. Fifteen hundred miles later the gears were found to be badly worn on the drive side and scored on the coast side. At this point the factory-fill lubricant was again installed with a new axle and the same brand of multi-purpose lubricant, but of the SAE 90 viscosity, installed following the break-in. With the 90 grade lubricant the car operated satisfactorily for about 3500 miles, at which time the car was sold.

Similar tests were run in 1955 cars. No scoring was detected in the 1955 tests in spite of the fact that some SAE 80 commercial multi-purpose lubricants were used.

Similar tests were also run in 1956 cars. In these tests one SAE 80 multi-purpose lubricant caused the failure of two cars, one at an odometer of 7533 and another at 7600. Pictures of the gear teeth from these two cars are shown in Figures 9 and 10. The very extensive scoring is clearly visible in these pictures.

These proving ground and research garage car tests provide ample evidence that SAE 80 multi-purpose

lubricants are definitely not adequate. Furthermore, the SAE 90 multi-purpose lubricants appear to have marginal anti-score quality. These conclusions are particularly significant when it is considered that the driving schedules in these tests are not unusually severe. While the proving ground durability test is normally considered to be more severe than ordinary customer service from a durability standpoint, there is no extreme shock-loading such as one obtains in a bump type gear test. Also the research staff cars are driven in normal service by research staff employees in traveling about the city of Detroit or to various divisional plants.

Establishing General Motors Anti-Score Requirements

This work, together with the field service indications of poor service lubricant anti-score quality have led to the efforts by the oil and additive manufacturers to develop an improved multi-purpose gear oil. General Motors has been very much interested in this development, and, in fact, as early as 1954, the new type lubricants, or at least their immediate predecessors, were installed in some of the research staff garage test cars. This was also true in the 1955 and 1956 tests. In none of the tests has any scoring been observed with these new lubricants in spite of the fact that some of them were blended in the SAE 80 grade. Our interest in the new type lubricant is further evidenced by the fact that research staff is presently running 34 cars in which Coordinating Research Council reference gear lubricants ranging in performance level from 5 to 15 are installed. Thirteen cars are running on factory-fill lubricant to provide a baseline in this work.

General Motors has also been very active in using



FIGURE 9 pictures gear teeth from 7,533 miles testing.



FIGURE 10 results are from Cadillac driven 7,600 miles.

gear lubricant performance scale in other test work. As soon as Mr. T. P. Sands of Monsanto Chemical company announced the CRC gear lubricant performance number scale, research staff and some of the GM car divisions began axle tests using the reference lubricants. Two types of score tests were run, one on new gears and one on gears following a 1,000 mile break-in. In the latter tests, the car was driven using a reference gear oil and a new axle for a period of 1,000 miles at a maximum speed of 50 mph and with very light accelerations and decelerations. At the end of the 1,000 mile break-in the lubricant was drained and the gears inspected for any evidence of surface distress. When no such evidence was found, the axle was reassembled, fresh reference oil was added, and a score test was run.

Various types of score tests were used throughout the corporation on the new and broken-in gears. These included the Cadillac axle scoring test procedure, Buick 10-A test, Oldsmobile 26 test, and the Chevrolet scoring test of rear axles for lubricants and gears.

As a result of a considerable amount of work using the reference gear oils, General Motors was able to establish that from the anti-score standpoint:

1. A performance level of 14-90 is required for new gears.
2. For field service replacement with gears which have been broken in for at least 1,000 miles, a minimum level of 10-90 is acceptable.

All of you are familiar with the history subsequent to this determination in that the Ordnance department has determined that a new military gear lubricants specification should be set at 10-90 and that the American Petroleum Institute subsequently determined that the terminology to cover this new type gear lubricant should be "Multipurpose type gear lubricant, American Petroleum Institute service GL-4."

As a result of these research tests, then, we are now able to say with some certainty that gear lubricants supplied in the service station at a minimum performance level of 10-90 will satisfy General Motors axles after they are broken in, from the anti-score standpoint. As I shall discuss later, it is important that we emphasize *from the anti-score standpoint*.

General Motors 1958 Axle Lubricant Recommendations

Now that the primary argument against the service multi-purpose lubricants of the past ten years has been overcome, we might, at first thought, expect a complete reversal of passenger car rear axle lubricant recommendations. The facts of the case, however, are illustrated in Figure 11.

In this figure are shown General Motors hypoid rear axle lubricant recommendations for 1958. As you can see they are essentially identical with the 1957 recommendations in that the lubricant type is still stated as "passenger car duty hypoid lubricant" or "multi-pur-

pose type gear lubricant" and that for drain interval one division still recommends 10,000 miles and four still recommend no drain. An additional recommendation to be included in the Chevrolet manual is the use of SCL type lubricant in the positraction axle.

1958 GENERAL MOTORS REAR AXLE LUBRICANT RECOMMENDATIONS

Lubricant Type	Drain Interval
Passenger Car Duty Hypoid	10,000 miles, or
Lubricant, Multi-Purpose	do not drain (4)
Gear Lubricant	

(SCL Type Lubricant Is Recommended for Use in the Positraction Axle)

FIGURE 11 shows little change for 1958 recommendations.

Experience with GL-4 Lubricants

What is the reason for this seeming lack of interest in the improved multi-purpose lubricants that the oil companies are only too willing to supply through their service station outlets? In answering this question, I believe it is very desirable to examine the development of the GL-4 material.

In all of General Motors work, the emphasis was placed on anti-score quality. In fact, Mr. Sands has emphasized on many occasions that the CRC reference lubricant performance scale was made up specifically as a measure of anti-score quality or anti-score requirements. It has taken time to begin to accumulate experience with the GL-4 materials from other aspects.

As with anything new and different, our rear axle engineers have been studying the GL-4 lubricants very carefully and have been reluctant to accept them wholeheartedly before first gaining a good background of experience with them. Some examples of the experiences that they have encountered with the new materials may indicate some of the reasons for their caution.

As mentioned previously, Cadillac uses a scoring test for testing lubricants and gears in which they repeatedly accelerate a car to high speeds and decelerate it rapidly by means of shifting the transmission to low gear position. In this test they make a record of the bulk axle lubricant temperature observed. A typical plot of such temperatures is shown in Figure 12. Here, a comparison is made between the lead soap active sulfur factory-fill lubricant and one of the new GL-4 materials. As you can see, the factory-fill lubricant stabilized temperature was about 240°F. In the case of the GL-4 lubricant, however, the temperature was about 360°F. This is the sort of observation that causes our engineers to want much more information on a lubri-

cant before they accept it wholeheartedly. It is recognized, of course, that this information was obtained in new gears, whereas the GL-4 materials would be used in broken-in gears, but nevertheless, the very fact that such a large difference exists is naturally cause for concern for the man who has responsibility for the satisfactory operation of many thousands of axle units in the hands of customers.

Another similar observation is shown in Figure 13 where sections of two leather seals are shown. The one on the left is the section which has been tested in lead soap active sulfur lubricant while that on the right has been tested in CRC 15-90 lubricant, both for 70 hours at 300°F. The pieces of material scattered around the section on the right are what remained of the leather portion of the seal tested in the CRC 15-90 lubricant. Here again we may argue with the relationship between this bench test and what happens in the field, but the fact that the engineer observes such a result is good cause for his skepticism. Some support is given these results by the fact that it was necessary to replace the leather pinion seal twice in each of two 25,000 mile proving ground tests on a GL-4 lubricant. In these particular tests, the GL-4 lubricant was installed with the new gear set so that test results may not be directly comparable to what one might expect in the field on broken-in gears. Nevertheless, such experiences cause the engineer to want to make further observations with a lubricant before he is satisfied that it will do the job in his product.

Further complications have been emphasized in the rear axle lubricant picture within the last year. One of these is reverse groan or what is commonly referred to as G-string whine. This is the noise that is obtained

under some conditions upon backing the car slowly. It is a very annoying noise, and one which gives rise to customer complaint. The fact that the GL-4 lubricants do not alleviate this condition is one more reason that the engineers are hesitant to recommend these new materials.

Still another observation made by our engineers is that the apparent pinion bearing pre-load increases considerably with the use of GL-4 lubricants. This increase does not occur with lead soap active sulfur gear oil.

Finally, a unit which is the subject of very intensive interest at the moment is the controlled slip differential. A typical unit such as used by our Chevrolet division and sold under the name "positraction" is shown in Figure 14. The particular advantage of this differential is that it permits driving under conditions of adverse traction where an ordinary differential might prove to be completely unsatisfactory. Under icy conditions, for instance, when a motorist might be stuck due to the fact that one rear wheel is slipping on ice, the positraction would control the differential action so that the torque would be supplied to the other wheel having better traction. The unit accomplishes this in the following manner: When torque is applied through the differential, the cross-shafts climb the ramps and compress the clutch packs to effectively connect the axle shaft directly to the ring gear. When one wheel tends to slip, the corresponding clutch pack is disengaged. This causes more of the torque to be directed to the other wheel and markedly improves the possibility of obtaining sufficient traction to negotiate a road covered with mud or ice.

In analyzing this type of device, it becomes evident

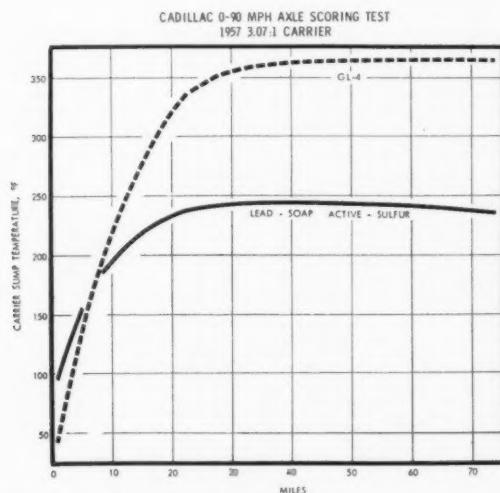


FIGURE 12 plots typical temperature in axle scoring test.

FEBRUARY, 1958



FIGURE 13. Seal test shows disintegration in CRC 15-90.

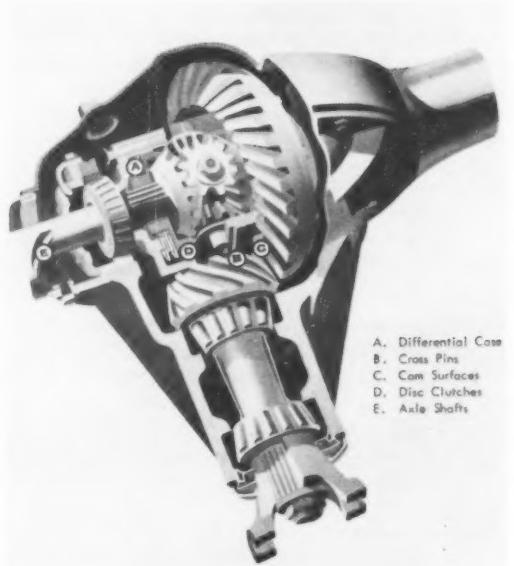


FIGURE 14. The Chevrolet "positraction" differential permits controlled driving under conditions of adverse traction.

that the engagement of the clutch pack must be smooth and that no stick-slip action can be allowed if the unit is to operate satisfactorily. General Motors has done considerable work in studying the compatibility of various lubricants with this new type of differential. This work has provided the engineer with another reason for his being somewhat hesitant to accept the GL-4 lubricant at this time.

In connection with this subject, Mr. Leonard Raymond of the Socony Mobil Oil company reported in his recent paper² on gear lubricants as follows: "The locking or non-slip differential is currently of interest to car manufacturers. Insufficient work has been carried out to date to establish the extent to which these units affect lubrication requirements because of so-called 'chatter' tendencies. The reports to date based

on limited work have been contradictory and confusing."

While there may be some confusion on an industry basis on this matter, the results obtained among the General Motors divisions appear to be in good agreement. The primary point of agreement is that the GL-4 lubricants simply do not work in the controlled slip differential. The difficulty arises in turning a corner with this type unit when using a lubricant that gives rise to stick-slip action in the clutch packs. The GL-4 lubricant causes a violent jerking on a sharp corner, especially when the brakes are lightly applied. From the results of tests on modified GL-4 lubricants, as well as other types of lubricants, it is known that the operation of the unit can be entirely satisfactory when the proper lubricant is used. Consequently, with the current very high level of interest in this type of unit and with the knowledge that this mechanism will not function on GL-4 lubricants, it seems quite reasonable that the engineer is reluctant to recommend the use of the GL-4 products, even in current equipment.

General Motors Tests Continuing

We are well aware of the extensive field experience, as well as test experience, on the GL-4 lubricants. We are continuing to test them at General Motors in an effort to learn more about them. The advantage of significant improvement in anti-score quality over previous multi-purpose lubricants is considered to be very important by our engineers. At the same time, however, with the evidence of the GL-4 material being significantly different from previous lubricants with respect to operating temperature, effect on seals, pinion bearing pre-load, and with the known incompatibility with the controlled slip differential, the engineers simply feel that they need more experience with this type of product and possibly a modified GL-4 before they can justify any change in lubricant recommendations.

References

1. "Hypoid Gear Lubrication," Professor A. O. Willey, SAE Southern California Section Meeting, December 8, 1939.
2. "New Horizons with New Gear Lubricants," Leonard Raymond, SAE National West Coast Meeting, Seattle, Washington, August 12-16, 1957.



About the Author

N. A. HUNSTAD is assistant department head of the fuels and lubricants department, research staff, General Motors corporation. He studied at Iowa State University prior to his army service in the machine records units of the Adjutant General's department

from 1943 to 1946, and obtained his B.S. degree in mechanical engineering in 1949 from Iowa. Hunstad joined General Motors research staff following graduation where his work has been primarily with lubricants. He is a past SPEAKSMAN author.



This is the second of a series of articles presented at the NLGI 25th annual meeting panel, "Lubrication of Contractor's Equipment," in October 1957. The remaining series will be published in succeeding issues of the NLGI SPOKESMAN.

Presented at the NLGI 25th annual meeting in Chicago, October, 1957.

Lubricating the

Construction

Giants

By G. K. Brower
International Harvester Company

Abstract

In this paper—"Lubricating the Construction Giants"—the author presents the viewpoint of the construction equipment manufacturer. The subject is most interesting. Geographically, it covers world-wide operations. Environmentally, it covers all extremes of climatic and operational conditions. Machines of many diverse types, destined for both military and civil use, are included. Shipaway, short-term storage and field service conditions are also of concern. Transcending all else, however, is the desire on the part of the equipment manufacturer to provide his customer, the ultimate user, with a set of simple, yet realistic lubricating instructions. Products recommended by one manufacturer should be capable of use with equipment produced by all manufacturers. Downtime and delays inherent in the use of multitudinous products cannot be tolerated. Equipment out of use due to failures attributable to errors in lubrication, caused by too complex lubrication recommendations, can be a major source of loss in the very competitive construction game. Equipment manufacturers do the best in their power to develop suitable lubrication instructions based on laboratory evaluation, proving ground operations, and field service testing. It is becoming physically impos-

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sible, however, to attempt to recommend lubricants by brand names or even to conduct performance tests which have any lasting value in view of the increasing number of products being marketed and the lack of any uniform standards against which their basic performance characteristics might be judged. This, then, is where the petroleum industry, as represented by the NLGI, could and should do a far better technical and public relation job than has been or is now being done.

Geographical Problems

INTERNATIONAL HARVESTER typifies the world-wide operations of one manufacturer. This company sells today in 147 countries throughout the free world; its facilities outside the U.S. include 14 factories, 18 subsidiaries and over 550 individual marketing facilities. Thus it can be seen that the manufacturers' first lubrication problem is to develop a simple set of lubrication instructions capable of being utilized not only within the confines of the continental United States but in many other geographical locations.

Equipment and Use Diversity

At first glance one of the most staggering aspects of the construction equipment industry is its never ending development of new equipment and new uses for old equipment. Typically, though, the major portion of such equipment will consist of crawler tractors including allied equipment such as cable or hydraulically controlled bullgraders and bulldozers, loaders (shovels), winches, pipe booms, etc.; rubber-tired units such as tractors, two- and four-wheel scrapers and bottom-dump wagons, graders, etc.; power units

either diesel, gasoline or gas; excavators, dragline and clamshell cranes, trench hoes, etc. Then too for each particular industry there are innumerable types of specialized equipment for each major use such as road construction, mining, pipelines, general use in massive water control projects, building projects and railroading. It is the admixture of these diverse monsters by the contractors and operators that poses the second lubrication problem facing the equipment manufacturer. This problem is to furnish recommendations, *including products of suitable quality*, which will permit the maintaining of a low inventory requirement.

At all times the manufacturer must keep in mind the problems of the ultimate user, his customer, and aim towards a satisfactory answer to this second lubrication problem. Naturally this is of the utmost concern to the contractor—for his economy, logistics of supply and service demands are stringent.

The Environment Problem

The third major lubrication problem confronting the equipment manufacturer is that relating to the wide range of climatic and operational environments to which his equipment will be exposed. Ambient temperatures must be considered. In general, the manufacturer will normally plan for the range of minus 25 to plus 110 degrees Fahrenheit. Special attention, of course, must be paid if operations are to occur outside of these limiting temperatures. Terrain may be the ocean sands, the arid wastes, coal piles, swamps and bayous, muck and mud, rock and all things imaginable. Operating procedures will vary, for each use and each piece of machinery, to an extent incapable of being



"AT ALL times the manufacturer must keep in mind the problems of the ultimate user . . . his demands are stringent."

predicted or described. But certainly the entire gamut from cycling, light duty to continuous high power output can be expected. Above all, however, will be severe shock loading and high unit loading of all chassis and allied equipment components including transmissions, hydraulic units, cable control units, and other related items.

Miscellaneous Problems

Several miscellaneous factors are also the cause of minor lubrication problems. One is the difference between the requirements of the military establishments and those desired for civilian use. This is not of major importance, however, as regards the military since they have clear-cut instructions and specification requirements. The construction equipment industry, on the other hand, is at variance with the military and is also plagued within itself with a plethora of recommendations and instructions. Another factor of minor importance is that caused by the varying factory-fill requirements of shipaway, short-term and dead storage procedures.

The manufacturers' task becomes, then, an attempt to balance product quality and availability with suitable preventive maintenance recommendations to the contractors. It is apparent that the author's job is to explain how the manufacturer tries to reconcile his lubrication recommendations in a manner desired by the contractor; and, at the same time satisfy the problems presented above. To do this, the experiences and methods of approach used by the construction equipment division of one typical manufacturer will be used as an example.

Complexity of Recommendations

Based on data obtained during an initial survey made approximately a year ago, the following figures will illustrate to some slight extent the complexity of presently accepted recommendations. Figure 1 shows how the viscosity-temperature range recommendations for engine lubricating oils were reduced from 21 to 7 for

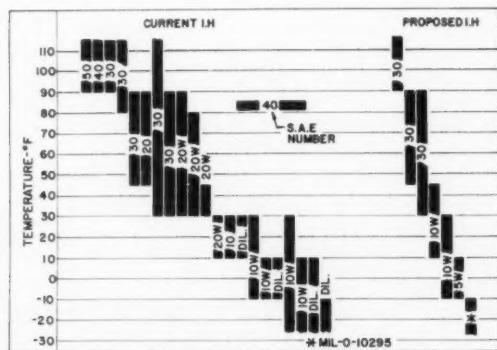


FIGURE 1. Current and proposed I. H. viscosity-temperature recommendations for engine lubricating oils.

one company alone. Figure 2 shows the industry trend for 14 differing companies. Forty-one viscosity-temperature recommendations by 14 manufacturers are to be noted. This is certainly not required and appears almost nonsensical. Doesn't this bespeak the need for industry-wide cooperation? Figures 3 and 4 depict the same sort of information for gear lubricants. You will observe one company reduced recommended temperature ranges from 12 to 4 and viscosity-temperature range recommendations from 19 to 8. For 14 manufacturers there are 21 temperature ranges and 31 viscosity-temperature combinations. Figure 5 again for one company, illustrates how several typical lubrication and related service recommendations could be and have been, at least numerically, simplified for an over-all reduction of 61 per cent. In other words $2\frac{1}{2}$ times as many recommendations as necessary were being issued.

Product Studies

Products now recommended by one manufacturer for the field lubrication of his complete line of contractor's equipment are listed in Figure 6. This is a subject of vital interest. The data presented may be disappointing to you for it is admittedly weak with respect to the paucity of factual laboratory data. Much of this weakness, though, lies within the province of your group to correct. The following comments are applicable to the products discussed and pertinent to the subject.

Engine Oils

The characteristics of these oils are not discussed in this paper since, I am sure, you all are most familiar with these products and the NLGI has more interest in other products. Suffice it to say, current performance evaluation tests adequately define the characteristics required in such oils by both the contractors and engine builders. In general, one of the following four oil types will satisfy any specific operation: MIL-L-2104A, supplement list No. 1, supplement list No. 2 (series 2), or series 3. It is indeed most un-

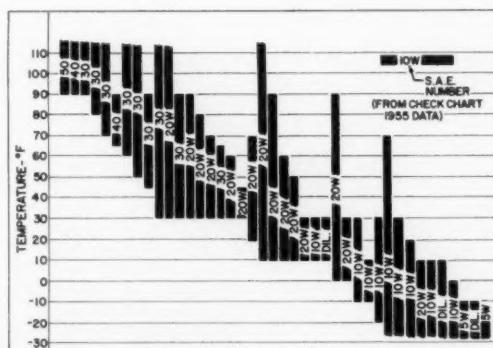


FIGURE 2. Tractor industry viscosity temperature recommendations shows trend for 14 differing companies.

fortunate that the SAE, for reasons beyond their control, permitted the adoption, promulgation, and the continued publication of unsound, unrealistic, and unused SAE Internal Combustion Engine Service Classifications for diesel automotive-type engines. It would be so simple, except for the stubborn obstinacy of a few, to relate these presently unacceptable service classifications to currently available engine performance tests. These latter tests are sanctioned and used by one hundred per cent of the automotive-type diesel engine builders and are also accepted and approved by both the construction equipment industry and the contractors. Since sound service classifications could be developed and would be used, why perpetuate an obsolete, unusable, and confusing terminology? The only purpose in stressing this rather distressing subject is to urge that the NLGI in their conduct of, or participation in, any cooperative work, as may be proposed herein, be truly honest and above partisan politics.

Hydraulic Fluids

Under this heading fluids utilized in torque converters, transmissions, and other hydraulic power components are considered. Operations of these units

are being adequately handled by fluids of the following five general types:

1. Hydraulic brake fluid, heavy-duty type, SAE standard SAE 70 R1. This is a non-mineral oil type similar to a castor oil-diacetone alcohol blend. It is used in hydraulic brakes supplied as special attachments on some units.
2. Diesel fuel is, among other uses, utilized in the torque converters of the twin-disc type.
3. Type C fluid—this is a product qualified by Allison for their torque-matic drive transmissions.
4. A proprietary fluid, of the petroleum base type, having a tightly controlled aniline point; for use in the touch control system of certain machines.
5. Engine lubricating oil, preferably SAE 10W is recommended for all other hydraulic units and associated components not included in the above four categories.

Universal Gear Lubricant

These lubricants are extreme pressure (EP) types or

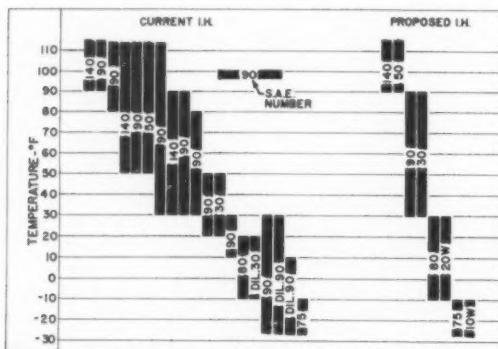


FIGURE 3. Current and proposed I. H. viscosity-temperature range recommendations for the gear lubricants.

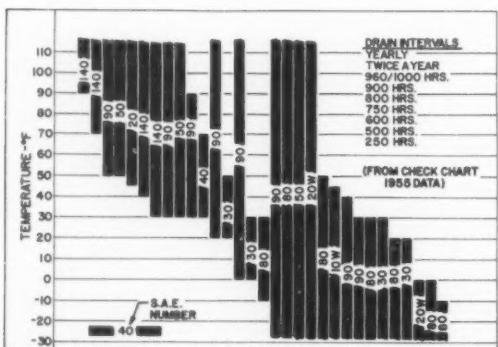


FIGURE 4. Tractor industry viscosity-temperature range recommendations for gear lubricants show wide variation.

Item	From	To	Percent Reduction
1. Crankcase Oil Temperature Ranges ...	13	7	46
2. Lubricating Oil—Viscosity Vs. Temperature Ranges	21	7	67
3. Oil Drain-Filter Element Changes ...	9	4	56
4. Generator	5	2	60
5. Wheel Bearing Inspection and "Repacking"	6	1	83
6. Wheel Bearing Grease Nomenclature	4	1	75
7. Starting Motors—Drain Intervals and Temperature Ranges	7	2	71
8. Fuel Injection Pump .	2	1	50
9. Air Cleaner-Viscosity vs. Temperature Ranges	5	1	80
10. Gear Lubricant-Viscosity vs. Temperature Ranges	19	8	58
11. Gear Lubricant Types	3	2	33
12. Hydraulic Fluids ...	6	3	50
Total	100	39	61

Standards Survey Cuts Lubrication Recommendations
(Only 2 Out of 5 Found Necessary)

FIGURE 5 illustrates how several typical lubrication and related service recommendations could be cut 61%.

EO (Engine Oil)

Refer to operators manual and chart below for type and grade.

*CL (Chassis Lubricant)

Use as pressure gun grease; all temperatures.

*HT (High Temperature Grease)

Grease qualifying under military specification MIL-L-3545 are recommended.

Note: MG (Magneto Grease)

May be used where alternately specified.

UGL (Universal Gear Lubricant)

Extreme pressure gear lubricant (EP) types and Universal gear lubricant (UGL) types which qualify under military specification MIL-L-2105 are recommended.

HF (Hydraulic Fluid)

SAE 10W engine oil unless otherwise specified by the given chart or guide.

*GP (General Purpose Grease)

Grease qualifying under military specification MIL-G-10924A are recommended.

*(Track Roller Lubricant)

At present optional.

*The desirable properties of these products might well be handled by one commonly available and economical product of suitable quality.

Products required by International Harvester Co.

FIGURE 6 lists products now recommended by one manufacturer for lubrication of his complete line of equipment.

universal gear lubricant (UGL) types which qualify under military specifications MIL-L-2105. Service experience with these gear lubricants has been entirely satisfactory in all cases when used in transmissions (including Fuller units), drives, gears, and track suspensions. Straight mineral gear oils were not capable of being used as a single standard for all equipment and their uses, nor were they capable of being adequately specified for procurement in the field. This latter factor resulted in service complaints prior to the adoption of the UGL type. The new super gear lubes (for service GL-4), having a rating of 10 or higher, have not been evaluated. There appears to be, as yet, only a limited need for a gear lubricant of this additive level in contractors' equipment. Further improvement in product quality and the receipt of data covering a broader range of service experience may alter this concept. Problems associated with the temperature stability (oxidation resistance) and corrosive activity at high operating temperatures (280-300 F) and in contact with all metals, appear to require further intensive study.

Chassis Lubricants

Are recommended for general pressure-gun use,

for all engine clutch points of rubber-tired units, for most water pumps and fan hub fittings, for magneto and distributor drive housings and distributor rotor shaft; sheave bearings, universal joints (except on torque converter models); and as may be otherwise specified. Little trouble has been encountered with the use of products in this category even though recommendations have not suggested their procurement against a specification. This would indicate that currently and readily available chassis lubricants are of uniformly high quality. This bespeaks well for the grease industry. For shipaway use this company's specification calls for a calcium or lithium type grease of NLGI grade 1.

General Purpose Grease (Or Multipurpose or All Purpose)

Is used primarily as a wheel bearing lubricant and at temperatures below 10 F in certain water pumps (packing type) and fan hubs. It is recommended that this grease be a product qualified as a MIL-G-10924A grease, automotive and artillery. This product has performed excellently as a wheel bearing grease and for low temperature general purpose use. At higher temperatures it did not do as good a job as had been expected. It is not readily available even within the major confines of the U.S. The development of an economical, generally distributed, multipurpose grease meeting appropriate requirements calls for immediate attention.

High Temperature Grease

Grease meeting the requirements of, or qualifying under, military specification MIL-L-3545 lubricating grease, high temperature, are recommended for use on the distributor breaker post recess and breaker arm rubbing block; the ignition cut-out switch; and on crawler tractors and power units only, for all universal joints, all engine clutch points, and all torque converter fittings. This product is not used on universal joints and engine clutch points of rubber-tired units since they do not operate under as severe conditions as the crawlers nor is a high temperature grease required for pressure-gun application at any other point; thus one gun is eliminated. The development and availability of an improved commercial version of a MIL-G-10924A lubricant would eliminate the need for this product.

Track Roller Lubricant

To the author's knowledge, there are no military, commercial, or industry specifications published or available covering track roller lubricants except one issued by Allis-Chalmers. This Allis-Chalmers product is for use in track rollers using roller bearings and metal-to-metal seals. For plain bearing types the International Harvester company in a Bulletin issued February 26, 1953, permits the optional use of semi-fluid lubricants. In such instances, the responsibility for the

quality of the lubricant and its performance in service remains with the supplier of the lubricant. Caterpillar Tractor company also specifies the use of a semi-fluid or thickened oil without the need to meet any specific requirement. Both laboratory performance tests and field service experiences have pointed out the weakness in such an approach. One company, in one program, tested 19 products of four basic types, i.e., straight mineral oil, UGL or EP type gear lubricants, inorganic gelled lubricants (thickened oils), and 5 variations of soap thickened products (semi-fluid greases). Of these products three differing basic types were each approved in some brand-named instances but not approved under other brands. In the field, products are continually being offered to distributors, jobbers, and contractors and stated to be entirely satisfactory for the intended use. Again results have been poor; with many reports of separation, leakage, "drying," or "balling" of the lubricant, etc., ad infinitum. The suppliers have yet to accept any responsibility for the poor quality of the lubricant with respect to its intended service or for its poor performance in service. There is both an overseas and a domestic demand for a track roller lubricant, of a semi-fluid yet tacky or adhesive type, for use on equipment required to operate under conditions which cause mechanical damage to seals; which cause excessive wear; and which cause high lubricant temperatures. Loss of lubricant and/or entrance of extraneous contaminants then becomes a field service problem. But—how is the equipment manufacturer to recommend which of the branded products are suitable and which are not, without some minimum base-line requirements? Again co-operative effort is needed, and your advice is requested, as to how to separate the chaff from the grain.

Performance Evaluation

In the normal course of testing equipment and the component parts, thereof, extensive laboratory and proving ground tests as well as cooperative field engineering and service evaluation tests with contractors utilizing all types of heavy equipment are conducted. At the company's own testing sites—carefully selected for their extreme climatic and ground conditions—vigorous examinations of machines and materials are made. On the scorching sands of Arizona a steady diet of heat and highly abrasive dust is the main foe to be vanquished. In the jagged hills of Missouri, all models are put through their paces in mud and water and over the toughest kind of terrain. Field engineering and service evaluations are then conducted under actual operating conditions. Additionally laboratory bench tests are utilized for screening purposes; for procedures requiring more control than full-scale tests; or for special studies such as illustrated in Figure 7 which shows a rig for evaluating track roller lubricants and seals and Figure 8 which is a view of a low temperature test facility capable of evaluating full-scale operating equipment at temperatures as low as minus 65°F and soaking tests to minus 80°F.

Though these facilities have been and are used to excellent advantage for the investigation of many materials and designs it is unfortunate that this expense cannot be spent for testing lubricating greases. As previously noted there are just too many brand name products and not a set group of recognized standards or classifications which could make test programs feasible. Field service results have given fair data and relations with contractors have been very good. In any particular instance, however, the range of conditions or problems have been limited and not conducive to a complete product evaluation project.

What Is Being, Can Be, and Should Be Done

During the past three months, it is of interest to note that related topics have been the subject of papers and discussions at two SAE meetings, to wit: The West Coast national meeting in Seattle on August 13 and the Farm, Construction and Industrial Machinery national meeting in Milwaukee on September 11. Figure 9 compares the essential data presented at these meetings with the data submitted herein. It will be observed that the author proposes an approach towards an even greater consolidation of products than has to date been suggested.

The lubricating grease technologists of the petroleum industry have been and are doing an excellent job of research, development and application with re-

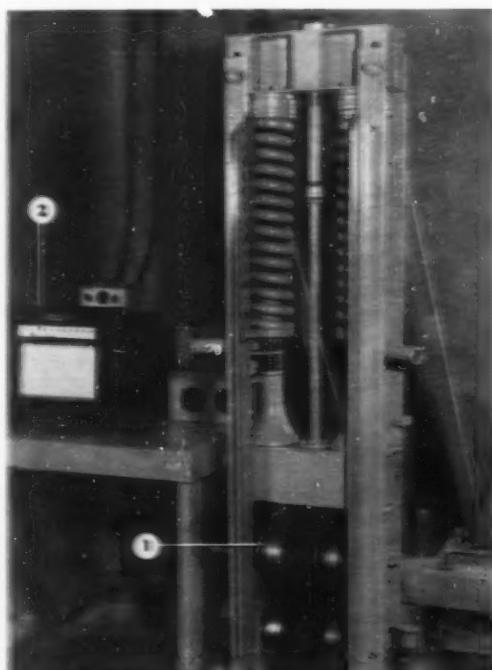


FIGURE 7 shows a test rig for evaluating track roller lubricants and seals. This is designed for special studies.

spect to improved products. Typical of the more recent work, with which the author is familiar, are those concerning an inorganic microgel grease, the development of sodium octadecyl terephthalamate as a new synthetic gelling agent, diamide carbonyl based lubricants; and the rheoplectic type products. Test procedure developments are not being neglected. Improved techniques for testing semi-fluid greases; grease bleeding characteristics, etc., are examples.

It appears then that the following actions could be and should be instigated:

Increased cooperative effort, on the part of us all, should be our first concern. It is the author's understanding that an SAE-NLG study group has been planned to work primarily with the passenger car groups on chassis lubrication problems. This study might well be expanded to include the needs of both the users and manufacturers of construction equipment; at least by an ad hoc committee. Perhaps a liaison effort with the SAE's CIMTC (Construction and industrial machinery technical committee), of which Mr. P. J. Sperry of International Harvester is

chairman, would be in order. Also I should like to quote the following as noted in the Seattle paper of August 12—"Among men looking for answers at the convention is Henry N. Ard of Lewiston, Idaho. He is chairman of a mechanical maintenance committee representing more than 100 logging firms. Problems he left with the engineers were—and how to cut down the number of lubricants needed to maintain logging equipment. His company keeps 528 products on hand for that purpose"—end quote.

Reference to this item was made in Figure 9. The 528 products are inventory items; actually 28 lubrication products were referenced. The fact that two such groups are working on similar projects adds further emphasis to the need for greater liaison and coordinated effort. This action should not be delayed, but should be effected in the near future. Maximum priority should be given to the development of "down-to-earth" recommendations on which the equipment manufacturer can base his instructions to the user and/or by which the user can obtain products recommended by the manufacturer. Brand names per se are not the answer, nor are meaningless service classi-

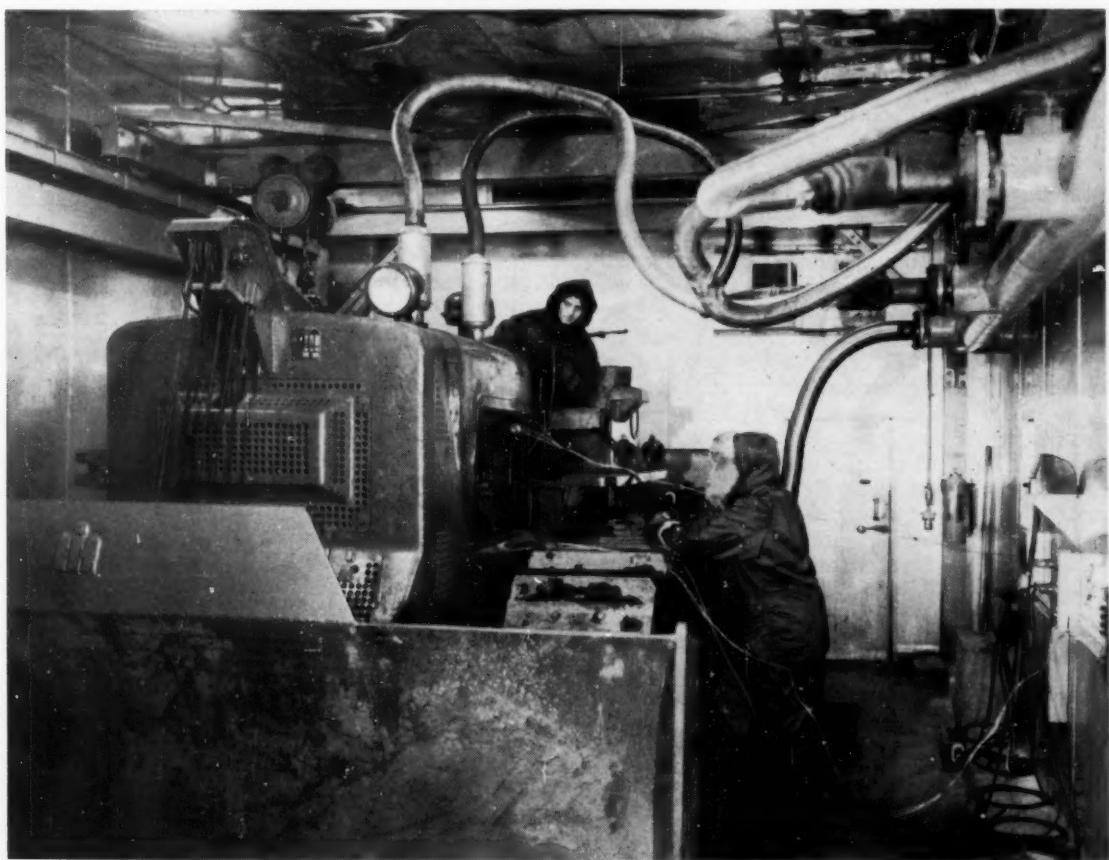


FIGURE 8. Low temperature test facility capable of evaluating full-scale operating equipment as low as minus 65 F.

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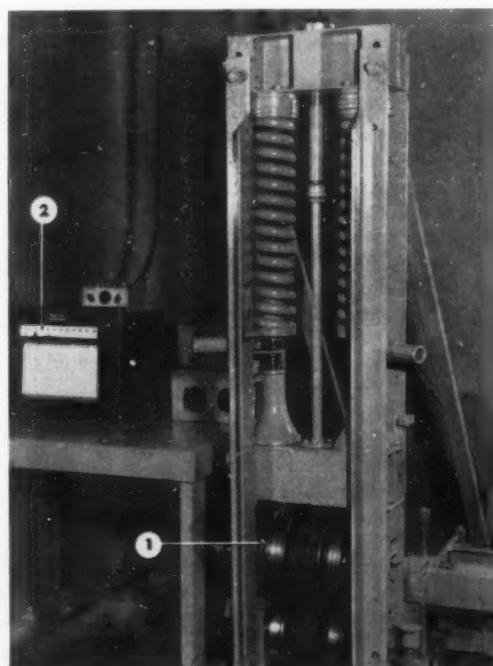


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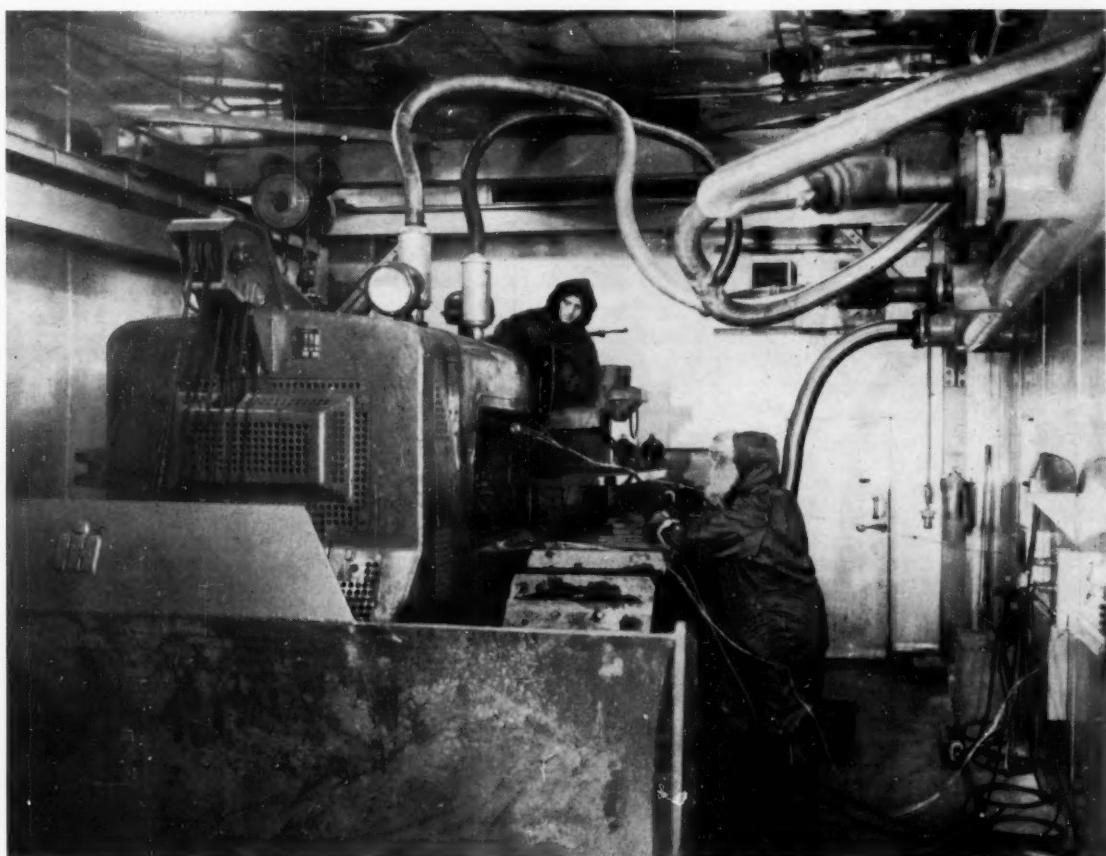


FIGURE 8. Low temperature test facility capable of evaluating full-scale operating equipment as low as minus 65 F.

	<i>Logging Equipment</i>	<i>C.I.M.T.C. Sub-Committee XVI</i>	<i>I.H.C.</i>
Engine Oil	X	X	X
Gear Oil Transmission	X		
Gear Oil Extreme Pressure	X	X	X
Gear Oil-Worm Gear Greases:	X		
Wheel Bearing or General Purpose or Multipurpose Type	X	X	X
Chassis Lube ...	X		X
Water Pump ..	X		
Cup	X		
Track Roller ...	X	X	Optional
Universal Joint..	X		
High Tempera- tures	X	X	X
Open Gear Lubricant ...		X	
Number of Products	11	6	5
Number of Types.	19	8 Est.	8

FIGURE 9 compares typical simplified lubricants recommendations, using the essential data presented at recent meetings and the consolidation of products seen by author.

fications based primarily on competitive marketing concepts. Brand names are to be wholeheartedly endorsed for the prestige they bring to recognized products and for the ease with which such products may be obtained within the confines of given marketing areas. Can there, however, be any serious objection to requiring that all products meet certain minimum performance and quality requirements? Under present conditions, the consumer cannot purchase, nor can the equipment manufacturer recommend, products with any assurance that they will perform satisfactorily in service, unless a brand name product with which they are familiar is spelled out. A manufacturer cannot afford to field test very many branded products, nor can he expect the customer to do so. The only alternative and an unsatisfactory one at best, is to base lubrication recommendations on some

published specifications. In general, for the lubricants under discussion the military requirements are used. These are good for the intended use but cover a much broader operating range than required for civil use. This factor forces compromises which often result in the finished products having somewhat poorer performance characteristics than desired for commercial use. Trade or industry standards or specifications are nil; thus an urgent need exists for the development of realistic and usable service classifications for all lubricating greases.

Your Institute is to be congratulated on the work your members have been and are doing as regards research, development and manufacturing. Now, the construction equipment industry would like to join forces with your industry in order that the benefits of your work might more readily and correctly be made available to ourselves and the users of our equipment. For having been granted the honor and privilege of appearing before you in this panel discussion, the author is deeply grateful.

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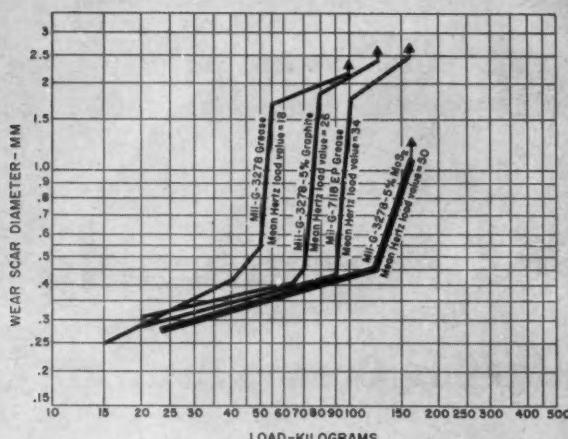
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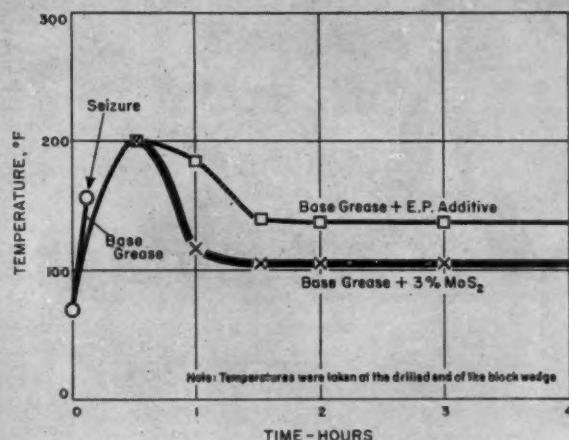
About the Author

G. K. BROWER is project engineer for International Harvester company in the construction equipment division, fuels and lubricants. He received his B.A. from Antioch college and his M.Sc. from the University of Pittsburgh. In 1931 he began work with American Airlines and attained the position of assistant director of re-

search. His later company affiliations include Ray Oil company where he was vice president of manufacturing, Kelite Products, as technical director and plant manager, and Armour Research Foundation, with the position of supervisor of special fuels and lubricants projects. The author's memberships include SAE, ASLE, ASTM.



4-ball E.P. test shows the superior extreme pressure properties of MoS₂ grease over the same grease without additives. In the same test, grease containing 5% graphite had a mean Hertz load value of 26; the conventional E.P. grease Hertz value was 34.



Timken endurance test clearly shows how MoS₂ functions when added to a base grease. With base grease alone, the specimen seized in about 10 minutes. With MoS₂ added, lubrication was effectively sustained throughout the test at a reduced temperature of about 100°, compared with a temperature of about 130° for the conventional E.P. grease.

Moly-Sulfide additive extends effective lubrication

Laboratory and field tests prove that chassis lubricants containing MoS₂ sustain lubrication after base grease is wiped off

When standard chassis greases are first applied to shackle pins, ball points and other bearing points under trucks, trailers and passenger cars, excellent results are obtained. These greases, however, are subject to mechanical motion, such as reciprocation, pressure, oscillation and shock loading which tend to eject the lubricant.

At this point, chassis grease containing 3% Moly-Sulfide proves its great value. MoS₂ is forced between the rubbing surfaces, adheres to the metal and forms a protective film that prevents galling, welding and fretting. The extent to which MoS₂ sustains lubrication is demonstrated by substantial reduction in wear.

Four tests show how MoS₂ reduces wear

- Shell 4-ball extreme pressure test** (see illustration)—MoS₂ addition reduces wear more than 50%, increases load capacity about 70% over base grease.
- Falex 2-hour wear test**—As the chart here shows, MoS₂ sustains lubrication, as proved by a reduction in wear, by an average factor of 500.

Grease	Loss in weight of specimen
Lithium-base	1,000 mg.
Lithium-base plus 2% MoS ₂	1.98 mg.—average of 3 runs

- Timken endurance test** (see illustration)—MoS₂ sustains lubrication well beyond the capabilities of the base grease alone, and at a lower temperature than conventional E.P. grease.
- Simulated shackle bolt service test**—oscillating friction machine—3% MoS₂ addition virtually doubles the effective lubrication of a lithium base chassis grease—is far more effective than conventional additions.

Hours to failure—average of 2 tests

Additive	None	3% MoS ₂	5% ZnO	15% ZnO
Dry	350	564	336	555
Wet	162	264	109	85

On-the-road use proves MoS₂ prevents chassis wear

A St. Louis company reports no noticeable wear on chassis parts of auto transport trailers, since they selected an MoS₂ chassis grease.

Based on their own tests, several major automobile and truck manufacturers use—and recommend—MoS₂ grease for torsion suspension units, ball joint suspension, as well as for many other critical-wear areas.

Moly-Sulfide greases are available from many producers today. For a list of the manufacturers of these greases—which includes several major oil companies—and for a copy of "Molybdenum Disulfide as a Grease Additive," write to Department 58, Climax Molybdenum 500 Fifth Avenue, New York 36, N.Y.



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Advantages of Membership in National Lubricating Grease Institute

DID YOU KNOW . . .

That the National Lubricating Grease Institute represents over 95% of the lubricating grease industry with members in this country and overseas? The membership list reads like a "Who's Who" in the lubricating grease and allied industries and is proof of the services that NLGI renders to its members.

Some of the advantages of membership are listed below:

NLGI has a Technical Committee of 154 members which is divided into nine sub-committees working constantly on industry problems. These committees are:

Subcommittee on NLGI Classification of Lubricating Greases

Subcommittee on Delivery Characteristics of Dispensing Equipment for Lubricating Greases

Subcommittee on the Procurement of Technical Papers for Publication in the NLGI SPOKESMAN

Editorial Review Subcommittee

Research Fellowship Subcommittee

Subcommittee on Recommended Practices for Packing Automotive Front Wheel Bearings

Subcommittee on Manual of Test Methods and Definitions of Terms Peculiar to the Lubricating Grease Industry.

Subcommittee on Fundamental Research

Subcommittee on Grease Pumpability Tests

Beginning with the production of lubricating grease for the year of 1957, NLGI is instituting a survey which can be of practical value in establishing sales and manufacturing data.

The NLGI SPOKESMAN, a monthly technical journal, is mailed free of charge to key personnel within a member firm. If extra copies of the magazine are needed, they may be purchased at half the regular subscription price.

The field of gear lubricants is now being covered by NLGI and will receive full attention by the organization.

The Institute works in close cooperation with affiliated groups, including SAE, ASTM, ASA, ASLE, ASME, SAE-CIMTC, and IOCA, on problems and accomplishments in the lubricating field.

The Annual Meeting is the highlight of the year and is usually held during the last week in October. It is a three-day session where papers are presented of unusual interest on technical advances, marketing problems, new developments by suppliers and packagers, and the needs of the consumers. Members of NLGI are allowed a substantial discount on registration fees at this meeting.

Recently NLGI completed production on a new movie entitled "Grease, the Magic Film" which is available at \$700 for the first print, \$500 for the second print, and \$300 for the third and subsequent prints. Members of NLGI are allowed a \$100 discount in each of the above three categories.

The main objectives of the National Lubricating Grease Institute are for the development of better lubricating greases for the consumer and better grease lubrication engineering service to industry.

If your firm is interested in becoming affiliated with NLGI, the national office will be happy to furnish further information concerning the organization. Just as 1957 was a banner year for NLGI accomplishments, 1958 promises to be even better with more scope and more member advantages.

ASME Dates of Interest to NLGI Members

1958 MEETINGS AND CONFERENCES

Meetings

Gas Turbine Power Conference and Exhibit
 Nuclear Congress (*Coordinated by Engineers Joint Council*)
 Aviation Conference
 Engineering Management Conference
 Instruments and Regulators Conference
 Railroad Conference
 Production Engineering Conference
 Maintenance and Plant Engineering Conference
 Metals Engineering—AWS Conference
 Management—SAM Conference
 Oil and Gas Power Conference and Exhibit
 Semi-Annual Meeting
 Petroleum Mechanical Engineering Conference
 Fuels—AIME Conference

Lubrication—ASLE Conference
 Annual Meeting

	Date	Hotel	Location
Gas Turbine Power Conference and Exhibit	Mar. 2-6	Shoreham	Washington, D.C.
Nuclear Congress (<i>Coordinated by Engineers Joint Council</i>)	Mar. 16-22	International Amphitheater	Chicago, Ill.
Aviation Conference	Mar. 17-20	Statler-Hilton	Dallas, Texas
Engineering Management Conference	Mar. 19-20	Somerset	Boston, Mass.
Instruments and Regulators Conference	Apr. 1-3	Univ. of Delaware	Newark, Del.
Railroad Conference	Apr. 9-10	Statler	Cleveland, Ohio
Production Engineering Conference	Apr. 10	Bancroft	Worcester, Mass.
Maintenance and Plant Engineering Conference	Apr. 14-15	Penn-Sheraton	Pittsburgh, Pa.
Metals Engineering—AWS Conference	Apr. 15-17	Statler	St. Louis, Mo.
Management—SAM Conference	Apr. 24-25	Statler	New York, N. Y.
Oil and Gas Power Conference and Exhibit	May 11-15	Bellevue-Stratford	Philadelphia, Pa.
Semi-Annual Meeting	June 15-19	Statler	Detroit, Mich.
Petroleum Mechanical Engineering Conference	Sept. 21-24	Cosmopolitan	Denver, Colo.
Fuels—AIME Conference	Oct. 9-10	Old Point Comfort	Old Point Comfort, Virginia
Lubrication—ASLE Conference	Oct. 14-16	Statler	Los Angeles, Calif.
Annual Meeting	Nov. 30-Dec. 5	Statler and Sheraton-McAlpin	New York, N. Y.

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Melting Point	86°C (187°F)	69°C (156°F)	50°C (122°F)
Acid Value	2.	178.	4.
Saponification Value	180.	188.	180.
Hydroxyl Value	160.	154.	171.
Heat Stability Loss of Acid Value (6 hrs. at 285°F)	NONE	24%	NONE
Loss of Hydroxyl Value (6 hrs. at 285°F)	NEGLIGIBLE	27%	NEGLIGIBLE

Samples and technical data on request.



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Battenfeld of New York Joins NLGI



G. W. Miller
Company Representative

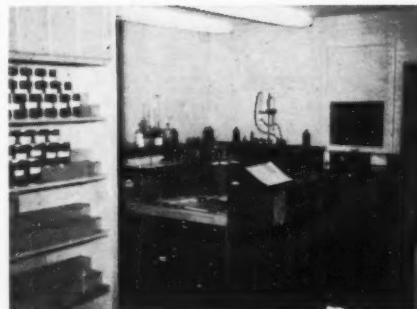
THE FIRST NEW MEMBER firm to join NLGI in 1958 was the Battenfeld Grease and Oil corporation of New York, with home offices in North Tonawanda. George W. Miller is president of the organization and NLGI Company Representative. Warren Miller is Technical Representative.

Coinciding with joining the Institute, Battenfeld of New York is pleased to announce the opening of new offices, research and control laboratories in the celebration of its twentieth birthday.

It will be of general interest to the industry that Battenfeld Grease and Oil corporation of New York has purchased the interest that Battenfeld of Kansas City held in the eastern corporation. The New York firm will continue to operate as an independent organization, doing business as in the past.

George W. Miller mentioned that the expansion indicates continued progress in research, product development and manufacture, and noted that there were plans for future plant expansion to handle efficiently all customer requirements.

As to Mr. Miller himself, he is known throughout the industry and has a long history of participation in the affairs of the National Lubricating Grease Institute. Serving as editor of the NLGI SPOKESMAN from its inception he retained this position for ten years, from 1937 to 1947. A vice president in 1937, he was the fifth president of NLGI in 1938. Beginning in 1939 he served as the secretary of the Institute for seven years until the organization's growth necessitated a paid executive to assume the duties Mr. Miller had carried, in 1946. For his many contributions to the Institute Mr. Miller was awarded the NLGI "Award to Industry" in 1952. He is one of six men to be so honored by the organization.

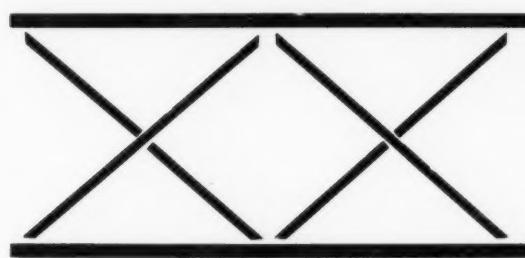


THE newly completed office facade and laboratory additions of Battenfeld of New York which are pictured above were opened in celebration of the company's 20th year.

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Patents and Developments

Saponified OXO Ester as Grease Thickener

U. S. Patent 2,779,736 issued to A. J. Morway, F. Knoth, Jr., and J. H. Bartlett, assigned to Esso Research and Engineering company. Process for subjecting a mixture of high molecular weight olefins (10-20 carbon atoms per molecule), e.g., tetrapropylene, penta-propylene, tetrabutylene, etc., with a low molecular weight alcohol (methanol, ethanol or propanol) to the Oxo-ester synthesis, i.e., carbonylation with carbon monoxide at 100-300 atmospheres, and 250°-400°F. in presence of cobalt or similar catalysts to produce an ester which is saponified with an alkali hydroxide (30-50% aqueous solution) at 280°-325°F. to produce a soap thickener for greases.

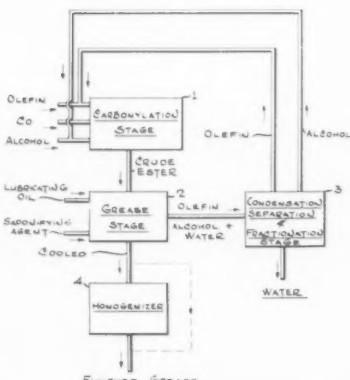


FIGURE 1 is a flow sheet of the process employed for patent 2,779,736.

In situ saponification in lubricating oil may be undertaken. Such soap may be combined with a suitable metal salt of a low molecular

weight aliphatic acid. Figure 1 shows a flow sheet of the process employed.

Thickeners by Alkali Fusion of Cyclic Alcohols

U. S. Patent 2,801,974 issued to A. J. Morway and J. H. Bartlett, assigned to Esso Research and Engineering company. Grease thickeners are produced by fusion of cyclic alcohols with caustic alkali at 500°-560°F. The alcohols have the formula R-CH₂OH where R contains a mono- or bi-cyclic group which may be naphthenic or terpenic. A suitable alcohol is sold as Nopol and is produced by the condensation of formaldehyde with beta pinene. This alcohol may be hydrogenated to Hydronopol which behaves similarly in alkali fusion. When the fusion is carried

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Color 1" Lovibond Yellow	15-30
Color Gardner 1933	9 max.
Unsaponifiable	2.5% max.
Saponification Value	198-205
Acid Value	197-204
% F.F.A. as Oleic Acid	99.0% min.
Iodine Value (WIJS)	60 max.

COMPOSITION

Myristic Acid	3%
Palmitic Acid	29%
Stearic Acid	15%
Oleic Acid	47%
Linoleic Acid	5.5%
Linolenic Acid	0.5%

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out in situ in lubricating oil, the sodium soaps of high molecular weight fatty acids may be used as suspending agents to prevent settling out of the alkali.

Basic Zirconyl Soaps

U. S. Patent 2,802,847 issued to W. B. Blumenthal, assigned to National Lead company. Basic zirconyl soaps of aliphatic monocarboxylic acids of the general formula $Zr_2O_3(OOCR)_2$, where R is an aliphatic organic radical of four or more carbon atoms, and suitable for incorporation into lubricating oils, are produced by dissolving a water-soluble zirconyl halide such as $(ZrOCl_2 \cdot 8H_2O)$, in water, adding sufficient carbonate (ammonium or alkali metal) to neutralize about one-half of the acidity of the solution, separately forming an aque-

ous solution of an alkali soap of a monocarboxylic aliphatic acid having at least four carbon atoms other than a carboxyl carbon per molecule, mixing the two solutions, and separating and recovering the basic zirconium soap precipitated. The product is a soft, white solid which is dried at 85°C.

Grease Thickeners from OXO Reaction Products

U. S. Patent 2,801,977 issued to A. J. Morway, J. H. Bartlett and J. C. Munday, assigned to Esso Research and Engineering company. Grease-forming soaps are prepared from the mixture of products resulting from the first stage of the Oxo process. This material contains about 20% unreacted olefin, 35% aldehydes, 10% esters, 10% alcohols, 15% acetals,

and 10% higher alcohol glycols, ethers, etc. This mixture is first subjected to hydrolysis at 80°-300°F to convert acetals to aldehydes and alcohols, then to dimerization at 30°-200°F in presence of alkali to condense certain aldehydes to aldols, then to querbetization of alcohols in presence of an alkaline catalyst to increase the yield of alcohols, and finally to an alkali fusion at 500°-650°F, wherein the unsaturated aldehydes are converted to metal soaps and the alcohols and esters also are converted to soaps. If desired, the reactions can be carried out in sequence without intermediate purification. Conventional soaps may be used with these thickeners in amounts of 5%-20%, based on the weight of the total composition. ■

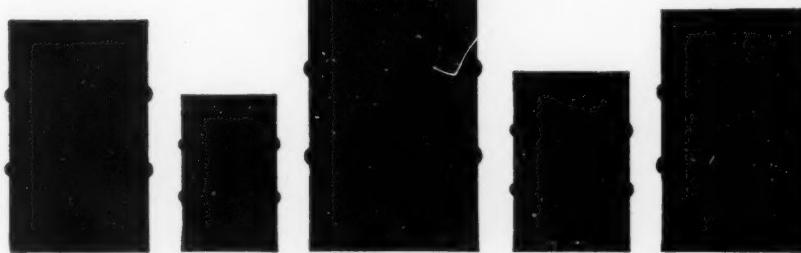
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People in the Industry

Pure Oil Appoints Hemingway Research Director



Hugh L. Hemmingway has been appointed director of research for the Pure Oil company, it was announced by Robert L. Milligan, president. Mr. Hemmingway will direct the activities of the company's research center at Crystal Lake, Ill., which will become his headquarters. C. M. Ridgway will continue as manager of the center.

Mr. Hemmingway, formerly general manager of the marketing division's sales-service departments, has been closely associated with Pure's research activities since joining

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ing the company in 1944. A mechanical engineer, he is a former president of the National Lubricating Grease Institute (1954-55) and is currently a member of NLGI's Board of Directors.

Two New Assistants Named

Robert J. Askevold and Dr. Donald C. Bond have been named to newly created positions as assistant research directors of the Pure Oil company, and Dr. Milton M. Marisic has been appointed assistant manager of the Crystal Lake research center. Mr. Askevold will be in charge of marketing and refining research activities, and Dr. Bond in charge of production and transportation research.

compounder of greases, gear lubes, cutting oils and lubrication specialties, retired at the end of 1957. Mr. Bunnell was one of the founders of the Company in 1925. He will continue to offer his services as manufacturing consultant to the company.

The new officers of Oil-Kraft, Inc., are Mr. Guy Peters, chairman of the board, Mr. Robert L. Peters, president, Mr. Matthew J. Kabbes, vice president, Mr. Clifford E. Mooney, secretary-treasurer, and Mrs. Thelma Mayhall, ass't. secretary-treasurer.

Saunders Directs Newly Formed Kerr-McGee Marketing Staff

All marketing operations of Kerr-McGee Oil Industries, Inc., includ-

Chek-Chart Elects Eldridge President



The Chek-Chart corporation has announced the election of Huntington Eldridge as president, effective December 18.

Formerly executive vice president of the firm, Mr. Eldridge succeeds the late Raymond Shaw, president and founder, who died December 8, 1957.

Mr. Eldridge, previously associated with the firm during its early years, returned to The Chek-Chart corporation as executive vice president, September 15, 1957, from the Stewart-Warner corporation, Almite Division.

J. R. Bunnell, Oil-Kraft President, Retires

Mr. John R. Bunnell, former president of Oil-Kraft, Inc., Cincinnati, Ohio, manufacturer and

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ing its subsidiary marketing companies, Cato Oil and Grease company and Triangle Refineries, Inc., have been placed under the direction of J. B. Saunders, senior vice president, in Oklahoma City.

Reporting to Mr. Saunders will be:

W. M. Murray, vice president in charge of general sales. Reporting to Mr. Murray will be L. H. Sullivan, manager, lubricating oil sales; D. R. Frey, manager, industrial oil sales; and L. W. Okon, sales technical services. Products handled will continue to include waxes, petro-latum, absorption oil, solvents, naphthas, lubricating oils, petroleum resins, refinery-produced propane and butane, and certain sales of gasolines and other products. Murray is a member of the NLGI Board of Directors and an NLGI past president (1955-56).

J. G. Campbell, who becomes general manager in charge of sup-

ply and distribution. Reporting to Mr. Campbell will be Ralph Gaden, manager, supply and product transportation; L. B. Rada, traffic manager, and R. D. Kruger, pricing and invoicing.

Branded gasoline sales departments will also report directly to Mr. Saunders. These departments include jobber sales, under R. B. Heuring; and station services under C. W. Dyniewicz.

Triangle Handles Gasoline

Triangle Refineries, Inc. will handle all of Kerr-McGee's unbranded gasoline sales through the Great Lakes pipe line and river sales at West Memphis, Arkansas.

Unbranded gasoline sales in Oklahoma and Arkansas will be handled by Claude C. Batchelor, who will report directly to Mr. Saunders.

Also reporting to Mr. Saunders

will be the merchandising department, which includes advertising and sales promotion, headed by W. J. Fuchs; and the marketing research and analysis department, headed by A. R. Gockel.

New Subsidiary to Be Added

Also under Mr. Saunders' direction will be a new subsidiary which is being organized with James J. Kelly as president to take over the marketing of asphalts and residuals, including both those produced at Kerr-McGee's refineries, as well as those produced by other refiners. A further announcement in connection with such subsidiary will be made shortly.

American Potash Names Hefler Financial Director

Richard J. Hefler has been elected vice president, finance, of American Potash & Chemical cor-

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Saponification value	198—205	197—203
Unsaponifiable content	1.5% max.	2.0% max.
Polyunsaturates	3% max.	

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American Potash

Continued from page 37

poration, according to an announcement by Peter Colefax, company president. The appointment was effective December 31.

Heffler, who joined American Potash in 1948, was named secretary of the company in 1953 and, additionally, assistant to the president in 1954.

Formerly With Hanover Bank

He formerly was with the Hanover bank in New York City and E. I. du Pont de Nemours & company at Wilmington, Del. During World War II he served in the Pacific in air intelligence of the U. S. Navy, attaining the rank of commander.

Heffler's education includes a bachelor of arts degree in business administration at Dartmouth college, graduate studies at Fordham Law school and New York university and a masters degree in business administration at the University of Southern California.

ASME Announces

O. B. Schier II Executive Secretary

O. B. Schier, II, has been appointed secretary of the American Society of Mechanical Engineers it was announced by James N. Landis, 1958 President of the 50,000-member group. Mr. Schier, who was designated secretary-elect last June succeeds Clarence E. Davies who was secretary of ASME for 23 years.

A Member Since 1932

Mr. Schier has been a member of the Society since 1932 and a member of the ASME staff for the past eleven years. He was elected assistant secretary in 1953 and named deputy secretary last December. A graduate of Lehigh university, he holds mechanical engineering and master's degrees from that institution.

The American Society of Mechanical Engineers, one of the nation's leading technical societies, is devoted to "the advancement of

the art and science of mechanical engineering and related sciences." With a budget of over \$2,000,000 per year it carries out a program of technical meetings, publications, research, preparation of codes and standards, and cooperation with national and international organizations.

Rogers, Standard Oil Executive, Retires

Dr. T. H. Rogers, director of research for Standard Oil company (Indiana) announced his retirement, effective January 3, 1958.

Rogers commented on the amazing growth and change of petroleum research since he joined the Whiting research staff in 1922. "Through the years, improved facilities for petroleum research by Standard Oil company, as well as other companies," stated Rogers, "and greater numbers of better

trained scientists and technicians have made available new and important products. Many of these have contributed directly to the spectacular development of our whole economy, from the cars we drive to the clothes we wear."

Lohrke,
Nopco
Sales
Manager,
Dies



O. E. Lohrke, sales manager of the Metasap Chemical company, a subsidiary of Nopco Chemical Co., died Friday, December 20. Funeral services were held Monday, December 23.

Lohrke was born in 1894 and

came to work for Metasap in 1923. In the 34 years he was with the company, Lohrke, through his faith in the future of metallic soaps, was a major force in building Metasap into a vigorous, active company, a reflection of his own approach to life.

H. F. Bennetts Dies

Harry F. Bennetts, former executive secretary of the National Lubricating Grease Institute, died January 8 in Kansas City. He was 52.

Mr. Bennetts served as the Institute's managing executive from 1948 to 1956, when he resigned. At the time of his death he was assistant editor for the Packer Publishing company and apparently suffered a heart attack while at work. Prior to joining NLGI Mr. Bennetts was manager of the Electrical Association of Kansas City.

News continued next page

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FEBRUARY, 1958

Industry News

Battenfeld and Southwest Grease and Oil Companies Announce Merger



H. A. Mayor, Sr.



A. J. Daniel

The merger of two of the largest grease manufacturers in the nation, Battenfeld Grease and Oil company of Kansas City and Southwest Grease and Oil company of Wichita was announced December 31, 1957.

The announcement was made by the presidents of the two firms which manufacture all types of lubricating greases. It was emphasized that the basic operations of both companies will remain the same and that no personnel or policy changes will be made. A. J. Daniel, president of Battenfeld and H. A. Mayor, Sr., president of Southwest will become joint heads of the merged firm. Neither firm name will be changed.

"The first cooperative effort of both companies will be in the field of research and development," a spokesman said. "From the combined laboratory operations will come the most complete, modern, well staffed research and development effort in the history of the independent grease manufacturing industry."

"Energetic and ambitious new products and product improvement goals have already been established for the combined task force."

The reorganization should be accomplished by March 1. The merger is subject to the approval of the stockholders of both companies and will affect the Battenfeld factory in Compton, California, a warehouse in Minneapolis and the Kansas City plant. The Kansas City operation has about 200 employees and covers about four blocks. The Battenfeld operation in North Tonawanda, N. Y., will not be a part of the merger. G. W. Miller, president of that firm, said plans for the future would be made public at a later date (*see next column*).

The Battenfeld firm was founded in 1919 by the late J. R. Battenfeld. Southwest was founded in 1933 by H. A. Mayor, Sr.

Both Mayor and Daniel are enthusiastic about the possibilities for both companies under the new organizational set-up. They feel that under the new plan the firms will be better prepared to meet the interesting challenges that are so clearly before their industry. With reorganization accomplished by March 1, 1958, well in advance of the normal seasonal upturn in the respective businesses, the chief executives feel the transaction will be exceptionally beneficial. Day to day operation of both companies will remain unchanged.

Each firm has figured in NLGI activity, the late J. R. Battenfeld being a founder and the first president of the Institute. H. A. Mayor, Sr., was a longtime (1944-52) member of the Board of Directors. A. J. Daniel is a member of the Board, a past president (1949-50) and is currently serving his sixth consecutive term as Treasurer. H. A. Mayor, Jr., is a Board member, chairman of the API-NLGI Joint Container committee and the NLGI Publicity committee, and serves as liaison representative for NLGI to the American Standards Association.

Battenfeld of New York Affiliates in NLGI Active Member Capacity

The Battenfeld Grease and Oil corporation of New York has affiliated with NLGI in an active member capacity. George W. Miller is Company Representative.

The firm, with headquarters in North Tonawanda, New York, is a manufacturer of lubricating greases and has long been a part of the industry through its former affiliation with Battenfeld Grease and Oil corporation of Kansas City (*see above*). For further details about the new member, see page 32.

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Major Oil Companies Introduce Moly-Sulfide Automotive Greases

In order to meet increased demands for automotive lubricants which reduce wear under conditions of mechanical motion and extreme pressure, three major oil companies have introduced lines of molybdenum disulfide chassis grease, according to a news release by Climax Molybdenum company. Cities Service Oil company, Socony Mobil Oil company, and Standard Oil company of Kentucky are now marketing Moly-Sulfide containing lubricants which they developed to solve certain critical lubricating problems, Climax people say.

Provides New Answer

When such difficult conditions as shock loading and motions of oscillation, reciprocation, or sliding are prevalent, it is claimed in the story that these new greases provide the answer. Moly-Sulfide, a chemical

compound with unusual lubricating properties, is the secret. It films out on metal surfaces and adheres tightly, sustaining lubrication long after the grease carrier may have been squeezed out or wiped away. This property makes it ideal for heavy trucks, farm equipment, and for passenger cars featuring such innovations as front suspension.

Extensive Testing Used

Each of the new products underwent extensive testing before being placed on the market. Climax men cite Socony Mobil's product, Mobilgrease special (with Moly) which was put to rugged tests on three different fleets of trucks. It proved particularly effective on the fifth wheels of trailer trucks, reducing wear substantially and increasing safety as well (it greatly lessens the chance of jack-knifing). This lubricant, a premium lithium grease with Moly-Sulfide added, is being marketed by Socony Mobil to bus companies, trucking firms, contractors, and other operators of commercial vehicles.

Cities Service and Standard of Kentucky sell their new greases both through their sales branches to commercial fleets and through their service stations to passenger car owners.

Cities Service calls its new grease Trojan HM Grease, while Standard of Kentucky distributes its product under the name Standard Moly MP lubricant. Both of these products are lithium base lubricants, the story concluded.

High Temperature Grease For Missiles and Planes Developed by Shell Oil

Shell Oil Company has developed a new class of greases for high temperature, high speed application in missiles and supersonic planes.

The new lubricants, called Shell ETR (extreme temperature range) greases, withstand temperatures up to 600 degrees Fahrenheit and protect metal parts running at speeds up to 30,000 revolutions per minute.

Continued on next page

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ute, the company said.

The lubricants contain an organic vat dye that serves as a thickener to improve heat stability and gelling efficiency.

Shell said company scientists began research on high temperature lubrication "years ago", when it became apparent that the highest quality soap base and petroleum oil greases would be inadequate for the operating conditions met in extremely high speed flight.

The new lubricant class includes two members: ETR Grease B and Grease D.

The company said its Martinez, Calif., research laboratory, which developed the products, is continuing research toward lubricants that will withstand still higher temperatures.

Battenfeld Holds Sales Meeting in Kansas City

Salesmen and representatives of the Lubricants Division, Battenfeld Grease and Oil corporation, met in Kansas City on November 8 and 9,

to review last year's sales program and to announce the division's plans for the new year.

C. E. Gore Directs Program

The program, presided over by Charles E. Gore, sales manager, included an expanded advertising program, sales promotion, stepped-up research and new products to be introduced to the lubricants industry.

Principal speakers were, T. N. Bath, general sales manager, George W. Krause, vice-president, research and development; C. J. Boner, chief research chemist, Keith Birkett, research chemist, and Hugh H. Bruner, executive vice-president.

American Potash Opens New Offices in Great Lakes Area

American Potash & Chemical corporation has opened a Great Lakes-Midwest territorial office at Chicago, according to an an-

nouncement by W. J. F. Francis, vice-president in charge of sales.

The new offices will service an area bounded roughly by North Dakota to Kansas on the west, Oklahoma to Arkansas on the south, and Kentucky to Michigan on the east.

John L. Anderson has been appointed manager of the Chicago office, located at 3557 West Peterson avenue. Anderson joined American Potash recently after serving as vice president in charge of sales for the George C. Peterson company, petroleum products distributors in Chicago.

Two sales representatives have been named for the new office. They are Edward C. O'Connor, who has been with AP&CC since 1955 as sales representative operating from Oskaloosa, Iowa, and Wallace O'Dowd, who previously was with Spencer Chemical company, of Kansas City.

"Opening of the new offices to provide better service for our cus-

Continued on page 44

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STOCK OILS**

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(Hydrogenated Castor Oil Products)



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FARM



INDUSTRIAL

Lithium base soap gels made from either Hydrofol Acids 200 or Glycerides 200 provide outstanding lubricant performance at extreme temperature ranges. They inhibit graining and produce lubricants with a fine, hard texture and a high dropping point. Their characteristics make fine greases even finer. They add outstanding water, temperature and shear resistance to the grease.

For more complete information on use of Hydrofol Acids 200 and Glycerides 200 in your grease formulations, write on your letterhead or telephone your ADM Representative.

SPECIFICATIONS

	HYDROFOL FATTY ACIDS 200 (12-Hydroxystearic)	HYDROFOL GLYCERIDES 200 (Hydrogenated Castor Oil)
Melting Point °C		
Titer °C	70-74	86-88
Acid Number	172-182	70-74
Iodine Value	4 Maximum	4 Maximum
Saponification Value	182-187	3 Maximum
Acetyl Value	133 Minimum	177-181
Hydroxyl Value	147 Minimum	138 Minimum
		155 Minimum

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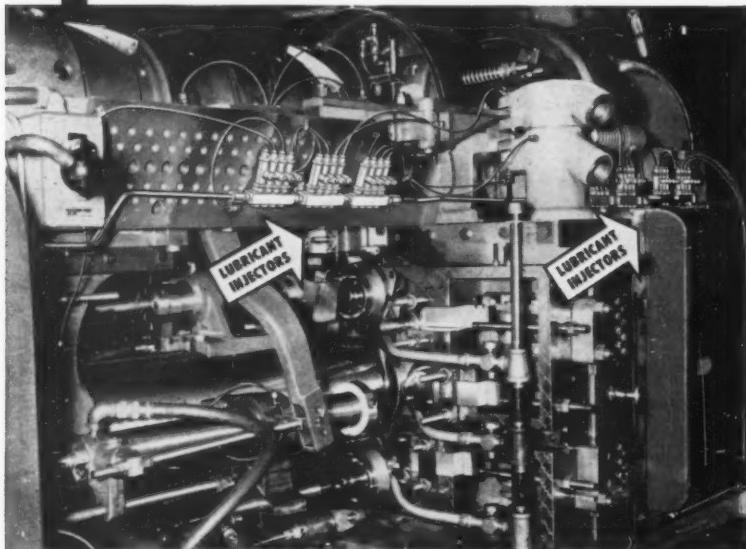
Hydrogenated and Distilled Fatty Acids and Stearic Acid
... Hydrogenated Vegetable, Fish, Sperm Oil and Tallow...
Hydrogenated Castor Oil ... Stearyl, Cetyl, Oleyl Alcohol
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American Potash Opens New Great Lakes Office

Continued from page 42

tomers was demanded by AP&CC's greatly increased business in the Great Lakes-Midwest area," Francis said in making the announcement. "It is a further step in the territorial realignment program begun three years ago because of the company's approximate 400 per cent increase in sales in the past ten years."

Administration of the new office will be from AP&CC's eastern general sales offices in New York.

New Lincoln Lubrication Equipment Catalog Issued

A catalog of the complete line of Lincoln lubricant application equipment has just been released. This manual is filled with dimension drawings—many in actual size. Also presented are the features of lubrication fittings, grease guns, centralized power lubrication systems and accessories. Ask for Catalog 92, from Lincoln Engineering company, 5702-30 Natural Bridge avenue, St. Louis 20, Missouri.

Alpha-Molykote Issues Lube Cartridge Bulletin, Type BR-2

Bulletin 114, covering the use of a Molykote, Type BR-2, lubricant packaged in cartridges and applied from a grease gun, has been published by the Alpha-Molykote corporation, Stamford, Conn.

Molykote, Type BR-2, is a lithium soap base heavy duty lubricant which combines the excellence of calcium and sodium soap thickeners with the amazing lubricity of molybdenum disulfide powder to insure water repellency, high temperature resistance, long storage life and the almost indestructible lubricating film characteristic of all Molykote Lubricants. The lubricant has an operating range of -30°F to 250°F and up to 350°F for short periods.

Type BR-2 in the handy grease gun can be used in extreme pressure industrial applications, in au-

NLGI SPOKESMAN

tomotive lubrication, and wherever a multi-purpose grease lubricant is required.

To obtain copies of Bulletin 114, simply write the Alpha-Molykote corporation, Stamford, Conn.

Sterling Fleischman Makes Drum Lift for Better Control

The Sterling, Fleischman company, Broomall, Pa., makers of the one-man hydraulic drum lift announce their newest product, Model CP-1, Sterling hydraulic drum lift for controlled pouring.

The unit is equipped with a mechanical arrangement for ease and safety in pouring drum contents. The gear reducer control device is completely enclosed and assures self-locking, and absolute control at any pouring angle. It is especially advantageous in affording the operator complete mechanical control where the contents of half empty



UNIT is equipped with mechanical arrangement for safety in pouring drum.

drums must be carefully poured. The pouring control affords maximum safety to the operator when caustic or toxic materials are being handled by enabling the operator

to remain well away from the pouring operation. The unit is basically designed to handle 55 gallon drums but can be adapted to handle other sizes in steel or fibre drums on special order.

The unit has a lifting capacity of 750 lbs. and drums can be raised to a height of 70" in a matter of seconds by a foot actuated hydraulic jack.

The CP-1 unit is ruggedly constructed of square steel tube and has a length of 49", height of 56½" and width of 38". It is mounted on 6" oil, gas and spark proof wheels for safety and ease of operation in hazardous plant areas.

For complete details and specifications write, Sterling Fleischman company, P. O. Box 94, Broomall 1, Pa.

Shell to Construct New Process Development Lab

Ground has been broken for a new process development labora-

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Shell New Process Lab

Continued from page 42

tory at Shell Development company's research center at Emeryville, California.

According to A. J. Johnson, vice president—development, the new laboratory will provide a valuable "test tube-to-manufacturing plant" stepping stone during the development of new petroleum products and petrochemicals.

The new laboratory is to cost approximately a half-million dollars.

The building, covering some 10,000 square feet of ground space, will be three stories high. Portions of its interior will be open from ground to roof to allow indoor construction of 35-foot models of distillation columns and absorption towers which in full scale will rise more than 100 feet.

"In this lab," Johnson said, "we will be able to develop processes for manufacture of new products to the point where they can be scaled up more quickly to commercial production.

"Certain processes that are successfully carried out in the laboratory are not readily transferred to pilot plant scale. Tests in the new process development lab will give us many of the answers before we go into pilot plant development.

"Also, expensive pilot plants—medium scale replicas of commercial units—may often be bypassed if tests in the new lab assure successful operation of commercial units," he said.

Werner Smith Develops Synthetic Fatty Type Oil

A new, synthetic fatty type oil known as Smithol 25 has been developed by Werner G. Smith, Inc., 1730 Train Avenue, Cleveland 13, Ohio. Manufactured from domestic raw materials, Smithol 25 claims a wider range of desirable properties than any of the natural oils, say the manufacturers.

This new oil has a pour point of 16° below zero, Fahrenheit, and a very high viscosity index (92.8 SSU at 100°F and 42.1 SSU at 210°F).

The oil resembles sperm oil in appearance and feel, but has only a slight popcorn-like odor that is not objectionable. Its iodine number is 105, hence, it can carry more sulfur than sperm oil. It produces light colored sulfonated oils. It is easily

sulfurized, sulfonated, or chlorinated, without forming gums or sediment. It is more easily emulsified than sperm oil and readily forms permanent or temporary emulsions.

Suggested applications for Smith-

Continued on next page

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Warner Smith Develops Synthetic

Continued from page 46

ol 25: sulfurized lubricant bases, sulfonated oils, cosmetics, cutting oils, wool oils, and textile lubricants.

Data sheets, samples and commercial lots are readily available.

New Books on Bearing Application Now Offered

A new book, *Bearing Design and Application*, has been co-authored by a frequent contributor to the NLGI SPOKESMAN and will be of interest to the industry. Donald F. Wilcock and E. Richard Boozer of the General Electric company are authors.

Dr. Boozer, manager, bearing and lubrication engineering, medium induction motor department, General Electric, has previously cooperated in writing papers for the SPOKES-

Emery Fatty Acid Sales Division Meets



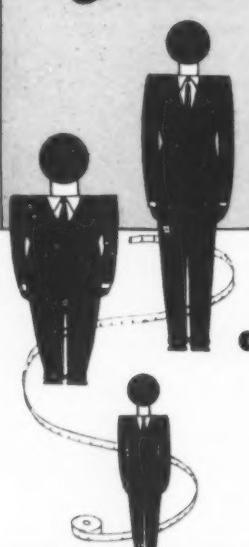
SALES representatives of Emery Industries' fatty acid sales department flank the framed samples of their top selling acids. The men were attending a three day sales meeting in Cincinnati, Ohio, which spotlighted the stearic division.

MAN which include; "Performance of Synthetic Greases," "Greases for Electric Motors," and "Mechanical Stability of Greases in Electric Motors."

Although the aim of the book is to provide machine designers aid in selecting the proper type of bearing for installations, considerable attention is given to the general factors influencing the selection of oil or grease as the lubricant, the quantity of lubricant required, some bearing - house - design considerations, and the desirable properties of oils and greases for various operating conditions. New performance evaluations of petroleum and synthetic oils and greases are also given. There are 225 illustrations.

The McGraw-Hill book company is publishing the six by nine, 470 page book. It sells for \$12.50.

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New Developments in Petroleum Packaging Developed at D. C. Meeting

At the December meeting of the Petroleum Packaging committee held in Washington, D. C. on December 3 and 4, the drum and pail subcommittee reported two new developments of considerable importance to the petroleum industry.

Both the national motor freight classification committee and uniform freight classification committee have approved the use of 22 gauge 120 lb. drums for shipping

Continued on page 50

NLGI SPOKESMAN

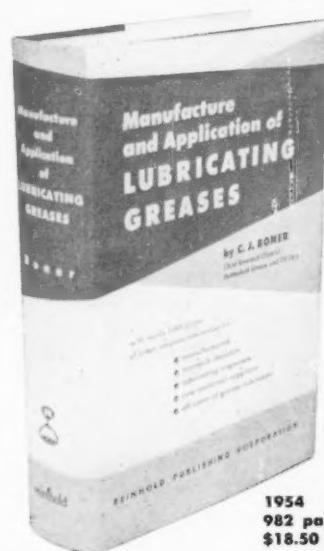
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- 8 Barium Base Lubricating Greases
- 9 Calcium Base Lubricating Greases
- 10 Lithium Base Lubricating Greases
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- 12 Lead Soap Lubricating Greases
- 13 Strontium Base Lubricating Greases
- 14 Miscellaneous Metal Soaps as Components of Lubricating Greases
- 15 Mixed Base Lubricating Greases
- 16 Complex Soap Lubricating Greases
- 17 Non-Soap Thickeners for Lubricating Fluids
- 18 Fillers in Lubricating Greases and Solid Lubricants
- 19 Residua and Petrolatums as Lubricants
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- 22 Application of Lubricating Greases
- 23 Trends in Lubricating Greases

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The book begins by describing in detail the structure and theory of lubricating greases. Then follow chapters on the various raw materials, processes and manufacturing equipment. Lubricants containing specific thickeners, including such recent developments as lithium soaps, complex soaps and non-soap gelling agents, receive special attention.

Of major interest is the large section on present uses and future trends of lubricating grease products. Here you'll find the complete details of when, where, and how to apply a specific lubricant for any given purpose.

Everyone concerned with the preparation or use of grease lubricants will find Boner's book of enormous practical value. Manufacturers and lubricating engineers will find here a complete breakdown of the effects of each ingredient or treatment upon the characteristics of the final product, and a full explanation of the physical and chemical methods used in measuring these characteristics. Suppliers of fats, oils, additives, thickeners and other raw materials will gain new ideas for future product research and development. In addition, users of grease products will learn the properties of available lubricants and the major purposes that each fulfills.

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Petroleum Packaging

Continued from page 48

petroleum oils. Reference to these approvals are:

"Shipments will also be accepted in steel drums meeting requirements of Rule 5, Section 8 (h) (3) and (5) except that drums over 10 gallons but not over 16 gallons capacity may be made of steel not thinner than 22 gauge. Drums must bear the initials "STC" to signify that drums are not again to be used as shipping containers after contents have been removed following initial shipment."

We have also been notified that the Uniform Freight Classification has also approved this usage. The authorization will be published in Supplement 5 to Uniform Freight Classification No. 4 effective January 15, 1958.

The Uniform Freight Classification specification will read: 'In steel drums meeting requirements of Rule 40, Section 5 except that drums over 10 gallons but not over 16 gallons capacity may be made of steel not thinner than 22 gauge. Drums must bear the initials "STC" to signify that the drums are not again to be used as shipping containers after contents have been removed following initial shipment'."

Tests were conducted on five gallon tight head drums made from the conventional 24 gauge metal and also drums made from 22 gauge, 26

gauge and 22 gauge heads and 24 gauge bodies. The conclusions reached are:

1. For non-regulatory products the 26 gauge is just as satisfactory as the 24 gauge.
2. The performance of the 22 gauge for regulatory products was not sufficiently better to warrant the 31½% increase in tare weight.
3. A drum with 22 gauge heads and 24 gauge body would have an increased tare weight of 7½%. It would give an increased life due to heavier chimes and would provide improved resistance to damage from much handling. It might be of interest to the U. S. Government for use on military shipments.

A nominating committee consisting of Mr. Robert Henry as chairman and Messrs. P. S. Nisson and C. Ray Irons was appointed by chairman H. A. Mayor, Jr. They are to nominate a slate of officers to be presented at the March, 1958 meeting.

The dates and locations of meetings to be held in 1958 will be announced later, with the exception of the March, 1958 meeting. This will be held on March 24 and 25 in Atlantic City. Headquarters will be the Haddon-Hall hotel. This meeting co-incides with the annual packaging machinery exposition, sponsored by the Packaging Machinery Manufacturers Institute.

NLGI Board Meeting

The regular quarterly meeting of the Board of Directors of the National Lubricating Grease Institute will be held in Detroit on Wednesday, February 26. The organization's governing body will convene in the Sheraton-Cadillac hotel.

Traditionally, the NLGI group has a meeting in conjunction with the session held by the API lubrication committee. Included in the Institute proceedings will be a report on the progress of the lubricating grease production survey and the motion picture, "Grease, the Magic Film" produced by NLGI.

Create Fatty Acid Division for Fatty Acids

The formation of the Fatty Acids division of the Pulp Chemicals association to handle the problems of its tall oil fatty acids manufacturers was announced by R. J. Spitz, its chairman. Mr. Spitz is also vice-president of Newport Industries company. The Pulp Chemicals association, of which this division is a part, was originally set up in 1947 to develop uses for the various chemical products of the kraft pulp industry. Tall oil fatty acids is the third such product to be included; tall oil (including crude, refined and distilled) and sulphate turpentine (both crude and refined) are the other two.

In commenting on the activation of the new division, Mr. Spitz stated that while fatty acid fractionation of tall oil did not have a long history, tall oil fatty acids have secured prompt acceptance in the field because of their uniform quality and the constantly increasing supply available. Tall oil fatty acids are being produced today at an annual rate of approximately 50,000 tons.

The initial program of the division will feature promotion of greater use of tall oil fatty acids among such industries as those which manufacture protective coatings, soaps, plasticizers, disinfectants, floor polishes, cutting oils and textile oils.

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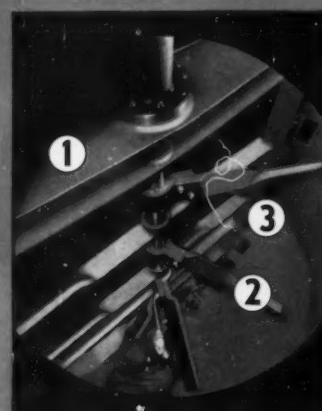
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Future Meetings

FEBRUARY, 1958

- 2-7 ASTM Committee D-2 Meeting, Rice Hotel, Houston.
10-14 ASTM National Meeting, Hotel Statler, St. Louis, Mo.
12-14 API Division of Marketing, Marketing Research Committee, Biltmore Hotel, New York City.
26-28 API Division of Production, Southern District Meeting, Shamrock-Hilton Hotel, Houston.
27-28 API Division of Marketing, Lubrication Committee Meeting, Sheraton-Cadillac Hotel, Detroit.

MARCH, 1958

- 4-6 SAE Passenger Car, Body and Materials Meeting, Sheraton-Cadillac, Detroit, Mich.
19-20 Ohio Petroleum Marketers Association, Annual Convention and Marketing Exposition, Deshler-Hilton Hotel, Columbus, Ohio.
31-Apr. 2 SAE National Production Meeting and Forum, The Drake, Chicago, Ill.

APRIL, 1958

- 9-11 API Division of Production, Mid-Continent District Meeting, Biltmore Hotel, Oklahoma City.
16-18 National Petroleum Association, Cleveland, Ohio
22-24 ASLE Annual Meeting and Exhibit, Hotel Cleveland, Cleveland, Ohio.

MAY, 1958

- 19-20 API Division of Marketing, Lubrication Committee Meeting, Point Clear, Ala.
21-23 API Division of Marketing, Midyear Meeting, Roosevelt Hotel, New Orleans

- 22-23 API Division of Production, Pacific Coast District Meeting, Biltmore Hotel, Los Angeles.

JUNE, 1958

- 8-13 API Division of Production, Midyear Committee Conference, Hollywood Beach Hotel, Hollywood, Fla.
8-13 SAE Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
22-28 ASTM 61st Annual Meeting, Hotel Statler, Boston, Mass.

SEPTEMBER, 1958

- 10-12 National Petroleum Association, Atlantic City, N. J.

OCTOBER, 1958

- 14-16 ASLE-ASME Joint Lubrication Conference, Hotel Statler, Los Angeles, Calif.
20-22 SAE National Transportation Meeting, Lord Baltimore Hotel, Baltimore, Md.
22-24 SAE National Diesel Engine Meeting, Lord Baltimore Hotel, Baltimore, Md.

**27-29 NLGI ANNUAL MEETING,
Edgewater Beach Hotel,
Chicago, Ill.**

NOVEMBER, 1958

- 5-6 SAE National Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

FEBRUARY, 1959

- 2-6 ASTM National Meeting, William Penn Hotel, Pittsburgh, Pa.

*MARCH, 1959

- 3-5 SAE Passenger Car, Body, and Materials Meeting, Sheraton-Cadillac, Detroit, Mich.

*Tentative

APRIL, 1959

- 21-23 ASLE Annual Meeting and Exhibit, Hotel Statler, Buffalo, New York.

JUNE, 1959

- 14-19 SAE Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
21-26 ASTM National Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

OCTOBER, 1959

- 11-16 ASTM National Meeting, Sheraton-Palace Hotel, San Francisco, Calif.
19-21 ASLE-ASME Joint Lubrication Conference, Sheraton-McAlpin Hotel, New York, N. Y.
26-28 NLGI ANNUAL MEETING, New Orleans, La.

FEBRUARY, 1960

- 1-5 ASTM National Meeting, Hotel Sherman, Chicago, Ill.

APRIL, 1960

- 19-21 ASLE Annual Meeting and Exhibit, Netherland-Hilton Hotel, Cincinnati, Ohio.

JUNE, 1960

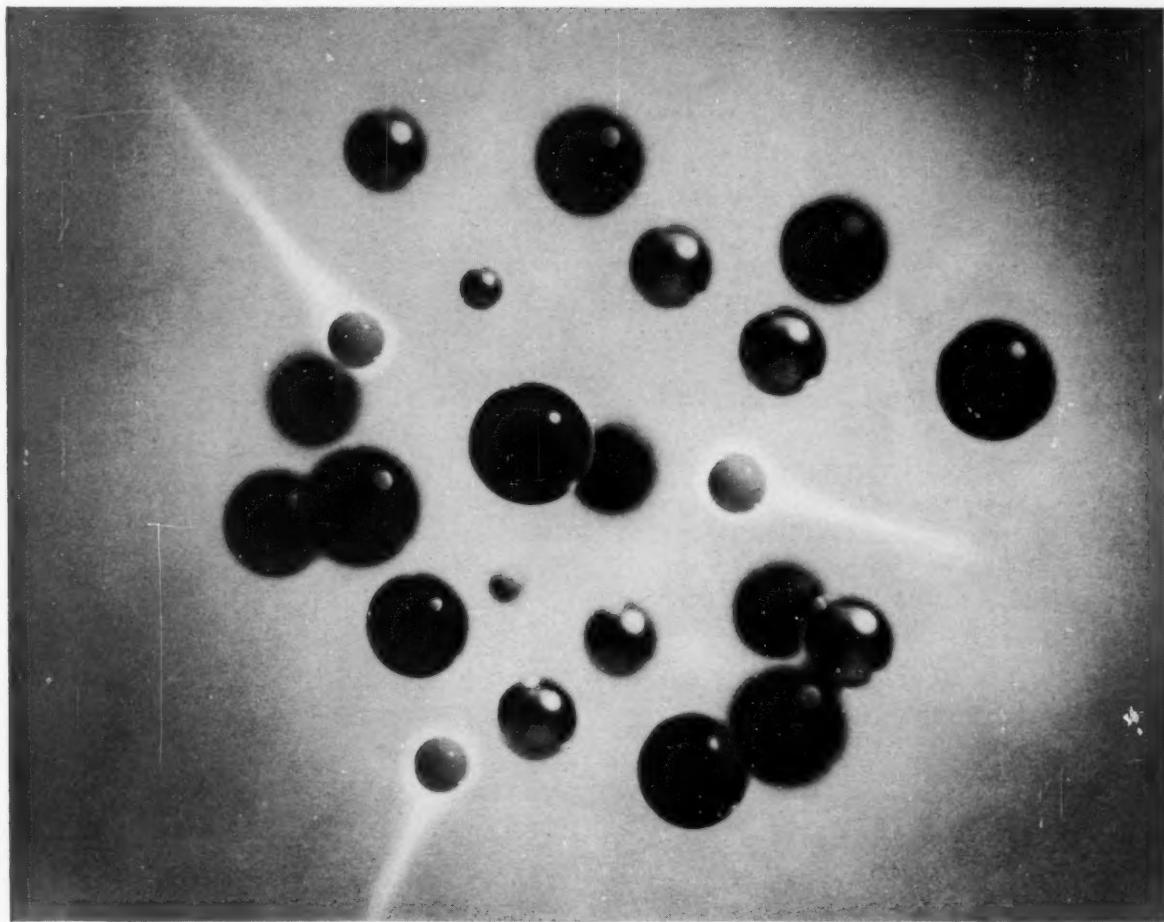
- 26 ASTM National Meeting with Exhibit, Chalfonte-Haddon Hall, Atlantic City, N. J.

OCTOBER, 1960

- 3-5 ASLE-ASME Joint Lubrication Conference, Hotel Morrison, Chicago, Ill.

APRIL, 1961

- 11-13 ASLE Annual Meeting and Exhibit, Bellevue Stratford Hotel, Philadelphia, Pa.



Visual concept of the behavior of lithium ions in a fused salt bath

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Lithium ions get around . . . in the tightest places!

The lithium ion really puts small size . . . high charge density . . . and directional properties to work. Unlike the ions of other alkali metals, it's trim enough and active enough to replace many other metals in a variety of crystals.

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and its high charge density can effectively decrease viscosity.

Small ionic radius, high charge density, and directional properties are just a few of the many unique characteristics that make lithium well worth investigation. Bring your knowledge of the subject up-to-date by requesting a copy of "Chemical and Physical Properties of Lithium Compounds"—a down to earth collection of facts, figures, and ideas on some 23 lithium compounds. Write the Technical Literature Dept., Foote Mineral Co., 402 Eighteen West Chelten Building, Philadelphia 44, Pa.



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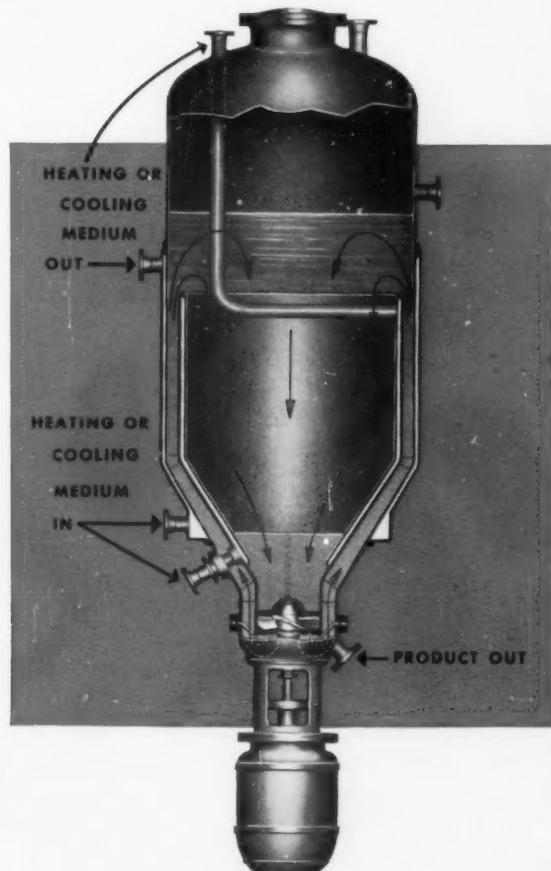
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